

FOREST RESEARCH
IN INDIA, 1931-32
PART II.—PROVINCIAL REPORTS. 72



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THE PROGRESS OF FOREST RESEARCH IN INDIA,

1931-32.

AN UNIFORM

PART II.—PROVINCIAL REPORTS.



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The Progress of Forest Research in India, 1931-32.

PART II.—PROVINCIAL REPORTS.

CHAPTER I.

GENERAL.

The reports from the provinces record many interesting investigations, and some results of considerably more than local value. In some provinces special research officers have not yet been appointed, in others the staff has been reduced as a measure of economy; the attitude in both cases is much to be regretted. The bulk of botanical, entomological and chemical research may have to be done by experts at the Forest Research Institute, but what they can accomplish is largely dependent on continuous assistance in the forests. Much the same applies to economic investigations though there is always some degree of private enterprise to supplement research, but in the case of silviculture organised research in the forests is essential. Silvicultural research aims not only at speeding up, improving and cheapening production, but in the first place at maintaining a supply of valuable timbers from certain areas. It is not generally known that reproduction of some of the more important Indian trees is obtained with the greatest difficulty, and yet the revenue of the forests depends primarily on success in overcoming this difficulty. The cost of the research involved is infinitesimal compared with the future revenues at stake.

Again the importance of systematic and continuous research is not always realised; investigations need to be co-ordinated and controlled, and once stopped they cannot as a rule start again where they left off. Forest crops take so long to raise that these requisites apply with special force; much good work done by divisional forest officers in the past has been wasted through lack of continuity and divergence of methods.

The Forest Research Institute is able to undertake a limited number of investigations and to give advice, or to take part in them by means of occasional tours, but its chief function is to co-ordinate investigations, and to collate, make known and to help apply results obtained. Any lack of local research not only deprives other provinces of valuable

results it may be possible to obtain, but the locality in question is not in a position to make the best use of results obtained elsewhere.

In Assam, the silviculturist's post was held in abeyance so that very little systematic research was done. The strip and group method is being adopted as most suited to *sal* (*Shorea robusta*) under local conditions. Excellent results are reported for natural regeneration experiments with *Terminalia myriocarpa*, and the planting of *Cinchona ledgeriana* shows promise.

Bengal has done much interesting work both in the *taungya* and plantation areas in the foot-hill divisions and in the very different South Bengal forests. The effects of burning young *sal* plantations to check their reversion to the damp conditions unfavourable to the species are giving interesting results, and intensive studies are progressing for the inter-connected problems of thinning and creeper damage. Artificial regeneration investigations with *gurjan* (*Dipterocarpus* spp.) have given results definite enough to be adopted as an established plantation procedure, *Tephrosia candida* being used as a nurse and cover crop. Underplanting experiments have been successful with *gurjan* and *Bambusa tulda* under teak.

In Bihar and Orissa, it has been found necessary to amalgamate the research officer's post with that for working plans and to reduce the subordinate staff also. A series of experiments has shewn that contrary to local belief, burning *sal* coppice coupes does not stimulate growth. Further experience has been gained in planting *sabai* grass (*Ischaemum angustifolium*). Heartwood volume tables have been published for *Acacia catechu*.

The necessity for retrenchment resulted in the 'closing' down of working plan field work in Burma, but experimental work was continued. Excellent natural regeneration of *Dipterocarpus tuberculatus* has been obtained under the clearfelling system, and the benefit of fire protection was demonstrated. A skeleton yield table for teak plantations up to 90 years old in three quality classes has been compiled and shows the Burma plantations to be about 10 years behind those of Madras in average diameter. Data have also been collected bringing out the very marked effect of thinning on diameter growth, and the benefit of improvement fellings for teak and *pyingado* (*Xylia dolabriformis*).

It is reported from the Central Provinces that agri-silvicultural regeneration methods continue to spread to new divisions. Forest grazing problems have been given special attention in collaboration with the agricultural and veterinary authorities, a classification of forest areas as primarily tree forest or primarily pasture being undertaken and series of experiments started to study the results of rotational closure.

In Madras, experimental work at the Nilambur centre was considered to have made such good progress with the local problems that a move to the Wynad was justifiable. A new centre was also started for the drier types of forest. Experimental technique has been much improved. Good results are reported with the artificial regeneration of felling gaps resulting under selection fellings both in deciduous and evergreen forest, especially with *Acrocarpus* and *Gluta*. Pre-monsoon stump planting of several species has shewn that good results are possible, but that too much depends on favourable weather conditions for the method to be satisfactory.

In the Punjab a research division was created; a study of the natural regeneration of fir and of alternatives to *shisham* (*Dalbergia sissoo*) in irrigated plantations where the water supply is short has started. A successful method of raising *Eucalyptus rostrata* in these plantations has been found and is being followed on an increasing scale. Some interesting studies have begun on the effect of altitude on the seed and seedling development of blue pine and deodar. Experience in the North-West Frontier Province has shewn that a certain amount of weed growth definitely helps blue pine seedlings to survive the dry season.

Work in the United Provinces continues to be concentrated on sal problems. Contradictory results regarding the effects on regeneration of burning, fencing and opening up the canopy have been obtained; treatment appears to need to be varied to suit different localities and further series of plots have been laid out to study this point. The first volume tables for *Quercus incana* have been published.

From Coorg various experiments with sandal wood regeneration are reported. Burning has proved advantageous in teak plantations in the second year. Bombay has also investigated sandal-wood problems and obtained marked success in growing it on a large scale with field crops.

Several provinces report steps taken to preserve permanently representative areas of forests of different types and exceptionally interesting trees.

The need for economy has affected botanical work in Assam and Burma. In the latter province the Forest Botanist was for some months Forest Economist and lecturer in Botany at the Rangoon University. It is to be hoped that this arrangement was only temporary.

The linear sample plots that Mr. Shebbeare has instituted in Bengal can be recommended for adoption in provinces such as Assam, Madras and Burma where the tree flora is rich and many species are unknown. In these linear sample plots a strip one chain wide is run straight through the forest and all trees on the strip over a certain fixed girth are numbered and botanically identified; they serve a number of purposes. They give a good idea of the flora and the proportions in which the different

species occur and they enable a man new to a district to learn to recognise the principal species and in cases of doubt he can find an authentic tree for purposes of comparison. Finally by periodic girth measurements some idea of the rate of growth of the less important species can be ascertained ; regarding this at present practically nothing is known.

In the Punjab and Bombay attention is being paid to ecology.

Trade depression is reflected throughout reports on the utilisation of forest produce, but investigations carried out indicate many directions in which it can be put to better and more extended use. Assam records an attempt to market creosoted poles, but without much success ; the price of the poles is not mentioned, but the advantages of treated wood must be better known before such ventures are likely to succeed. In Bengal and the Central Provinces timber that would otherwise be wasted has been milled with satisfactory results, and in the latter province transport by motor lorry trailer has been a marked success. In Bihar and Orissa a serious decline in the output of *sabai* grass (*Ischaemum angustifolium*) is reported and this is ascribed to the neglect of cultural operations, mainly weeding.

The Forest Department in Burma has issued a number of publications of interest to those intimately concerned with the timbers in question. Owing to better demand for box shooks and furniture of indigenous timbers the output of kiln-seasoned wood was increased. Valuable information is recorded regarding the resistance of timbers to attack by the *Toredo* in Rangoon harbour, and an investigation of the best methods of felling bamboos has been started.

In the Punjab the effect of different methods of stacking railway sleepers was studied, and in the United Provinces the successful production of *badami* papers from *dab* grass (*Eragrostis cynosuroides*) is reported ; this grass is abundant and it is hoped to make it suitable for fully bleached papers.

There are several features of interest in the entomological reports. Attention is being concentrated on the major pests of teak defoliators, the sapling borer (*Dihammus cervinus*) and the bee-hole borer (*Xyleutes ceramicus*), the last being confined to Burma. The Chrysomelid defoliator of *Gmelina arborea* is a serious pest in plantations and control measures proposed have yet to be fully tried out before definite conclusions as to their efficiency can be made ; control by mass breeding of parasites seems promising. The efficient control of the bag worm attacking *chir* in Rawalpindi, Punjab, by crows is particularly interesting. No epidemic attacks by the *sal* borer, *Hoplocerambyx spinicornis*, are reported ; it seems that trap-tree control is highly efficient.

The advance of forest entomology in India is seriously handicapped by the very small entomological staff of the Forest Research Institute

which is quite out of proportion to the problems which have to be solved ; adequate control methods can only be devised for any pest after prolonged observations on the spot. Some years back a scheme was put forward for trained entomologists to deal with the insect problems of three groups of provinces. Except in Burma where there is now a Forest Zoologist, this came to nothing. An alternative scheme, although not ideal, which should help to rectify the deficiency, is under consideration. The proposal is that each province should have an Entomological Range Officer, who after a short practical course at the Forest Research Institute will be able to supply data and to supervise control measures advised by the Forest Entomologist. The selection of the right men is of course a matter of the utmost importance.

A study of soils in relation to their individual silvicultural problems has engaged attention in several provinces. Sometimes attempts appear to have been made to reduce the nature of soils to a single factor, but this cannot offer a satisfactory solution as soils are very much more complex in nature than is commonly realised. It is advisable to make as complete a study of soils as possible before conclusions are drawn, and it is suggested that the Forest Research Institute should be consulted when considering the range of an investigation to be undertaken.

The reports received from the provinces follow, but some have had to be summarised or curtailed. A list of officers employed exclusively on research, and lists of publications in the provinces and at the Forest Research Institute, form appendices.

CHAPTER II.

SILVICULTURE AND WORKING PLANS.

ASSAM.

I. EXPERIMENTAL SILVICULTURE.

1. General.

Up to December of 1931, when both Conservators went on leave, the duties of Silviculturist were attended to by each Conservator in his own Circle. From December to March 1932 the post remained vacant. No new work was done, but all experiments previously started by the Silviculturist were maintained. During the year, as the result of a resolution passed by the Retrenchment Committee of Assam, and as recommended by the Government of Assam, the Government of India approved that the post of Silviculturist should, as a measure of economy, be held in abeyance until the cash balance of the province reaches a figure of Rs. 30,00,000.

2.—NATURAL REGENERATION.

(a) *Under Silviculturist.*

The experiments with a view to obtaining natural regeneration of *hollock* in the Sadiya Division mentioned in last year's report are reported to have given very excellent results. Experimental Plot No. 3 is reported to be an unqualified success and it has been ascertained that the prevailing wind direction is 165° — 175° . Experimental Plot No. 2 which was intended to be an advance towards the strip system of regeneration has been included in an area of 14 acres which was treated by Divisional Forest Officer with the idea of improving upon the experience gained in Experimental Plot No. 3 above. The area originally selected was 5 acres. The work of clearing was commenced late and not completed before 1st week of February 1932. The report is however that at the close of the year results were very promising.

In the old Experimental Plots Nos. 3 and 4 of Lakhimpur Division, it is reported by the Divisional Forest Officer that there are definite signs that advance growth has been benefitted.

(b) *Under Divisional Forest Officers.*

Sal (*Shorea robusta*) occurs in the following Divisions of the Province, viz., Garo Hills, Goalpara, Nowgong, Darrang and Khasi Hills. In the Khasi Hills and Garo Hills there are no experimental plots for

natural regeneration in all its stages. In Goalpara the only experiment reported on is an area of grass land in Western and Central Ranges which contain natural regeneration and which has been fenced and fire-protected. In Kamrup, the Divisional Forest Officer reports that the observation plots established in 1927, which formed the basis of the method of regeneration prescribed in the Working Plan, have served their purpose and indicate that opening up by groups and strips is the general policy to be adopted. He considers, however, that further research plots are needed to discover the optimum size of groups and the rate at which establishment really does take place under varying conditions. In Nowgong experimental burning over 222½ acres in Compartments IV, VI, and VII was continued. The Divisional Forest Officer reports that there is less *Acacia intsia* and more *batta* (*Imperata*) grass on the area. This area includes the area of 140 acres reported to have been thinned in 1928-29.

Natural regeneration in evergreen forests continues to interest a few Divisional Forest Officers.

In Sadiya 50 acres of this year's coupe in *hollock* forest together with 5 additional areas were treated on lines similar to those in Silviculturist's Experimental Plot No. 3 with slight variations which all appear to have given good results.

3.—ARTIFICIAL REGENERATION.

(a) Under Silviculturist.

Experimental Plot No. 9 was written off during the year. Experimental Plot No. 8 was maintained but the locality does not appear to suit *bonsum* (*Phoebe hainesiana*), the soil being clay appears to be too cold and wet.

(b) Under Divisional Forest Officers.

In Sylhet an attempt was made to introduce *sal* in a small plot, 1 acre in extent, seeds were sown in lines with *bogamedeloa* (*Tephrosia candida*). The seeds were attacked by white ants. The area is outside the regular *sal* zone.

In Nowgong an area of 20 acres of *sal* plantation was selected in Kholahat Reserve, Compartment VI, to ascertain if the cost of weeding young plantations can be reduced by burning; the results are said to be promising—*vide* remarks in Western Circle in last year's report. The experiment of introducing *bonsum* in Compartment XII, Kholahat Reserve, was continued as were also those with *sam* (*Artocarpus chaplasha*) and *amari* (*Amoora wallichii*) under *bogamedeloa* and the *amari* and *bonsum* plantations mentioned in last year's report as having

been laid down at Dhansiri. In Lakhimpur the *chaulmugra* (*Taraktogenos kurzii*) plantation under shelter-wood was maintained.

(ii) *Natural Regeneration (other than Experimental Plots).*

In *sal* areas in Goalpara and Kamrup the general impression is that *sal* regeneration will not be difficult provided we can introduce *batta* grass into all areas where regeneration is to be undertaken. In the report of the Western Circle for last year this was emphasised. There appears to be some doubt however in the opinion of the present Divisional Forest Officer of Kamrup as to the rapidity with which and method by which it will be possible to establish the requisite conditions of soil and soil cover for this purpose. It is too early at present to discuss this here. Remarks at 2 (b) may also be read in this connection.

In Darrang an area of about 10 acres in Garumari Reserve was cleared of undergrowth and revealed a healthy profusion of advance growth. There is apparently no lack of natural regeneration in the reserve both in the whippy and fleshy stages.

In the evergreen and semi-deciduous types of forests there are no areas which are being regenerated on a large scale under special arrangements. Generally speaking it can be said that many species regenerate themselves naturally but require proper tending to advance. Any work which has been done in this connection in the past is entirely experimental and no definite conclusions can be drawn at present except that tending in youth is essential.

In Sylhet the *myrtenga* (*Bambusa tulda*) bamboo is said to have regenerated very well.

(iii) *Seeds.*

The year appears to have been a bad one for *sal* seed but from Kamrup there is a promise of a good seed year 1932. Teak (*Tectona grandis*) at Kulsi seeded moderately well. *Hollock* in Sadiya seeded fairly well.

(iv) *Nursery Work.*

(a) *Under Silviculturist.*

No remarks.

(b) *Under Divisional Forest Officers.*

A nursery was laid out on Tura Top in the Garo Hills with a view to trying if *Cinchona ledgeriana* can be grown in the Garo Hills at a height of about 4,000 feet above sea-level; seed was sown on 4th April 1932 and started germination on 20th April 1932.

(v) *Artificial Regeneration.*

There is no special feature of the work which needs mention.

The total area under plantation and *taungyas* at the beginning and close of the year is 12,411 and 13,560 acres respectively.

(vi) *Miscellaneous.*

The *Cinchona ledgeriana* plantation referred to in last year's report was the subject of a special report to the Government of Assam during the year. The writer quotes below extracts from the report by Mr. W. R. Martin, Divisional Forest Officer, Sibsagar, which go to show that the species apparently might do very well in the Mikir Hills if tried on a large scale :—

"In April 1928 two ounces each of *Cinchona ledgeriana* and *C. succirubra* were sown in specially prepared nursery beds on the site selected by Mr. Osborne of the Bengal Cinchona Plantations, Mungpoo, when he visited the locality in February 1927."

"This area is situated on the northern slope of Cheniabenshon (Kala Parbat) at an altitude of approximately 1,400 feet."

"In transplanting in April 1929 the seedlings were put out at intervals of 6 feet by 6 feet. Out of 523 plants put out 493 were in a vigorous condition at the end of March 1930. Thirty plants had been reported to be in a poor condition at the time of transplanting, and these presumably died."

"The average height of the plants in December 1931 is given as 10 feet, but many of them were from 12 to 15 feet high, and all were in an exceedingly vigorous condition."

I give below details of the cost of experiment to 31st March 1932 :—

	Rs.
"Cost of 2 ounces <i>C. succirubra</i> seed at 50 per oz. . . .	100
" 2 " <i>C. ledgeriana</i> " 50 "	100
Cost of preparing nursery, clearing and burning plantation site, sowing, transplanting and tending to 31st March 1932 . .	286
TOTAL	486 "

Mezankori (Litsea citrata) was put out experimentally in the Holongapar Reserve and in the Sola Reserve. The results in Holongapar are reported to be good but no germination was obtained in Sola Reserve. Attempts with the species in Sadiya failed.

In Sylhet an experiment has been started with *tung* oil (*Alleurites fordii*). Out of 127 seeds sown in May 1931, 30 seedlings were obtained during 1931 and 2 in 1932. The plants were put out in Tilagarh Fuel Reserve in May 1932 in specially prepared holes and are reported to be doing well.

II.—WORKING PLANS AND STATISTICS.

(i) *Working Plans.*

With the concurrence of the Government of India the post of one Working Plan Officer was kept vacant.

The Working Plans for Goalpara, Kamrup and Shillong by Dr. N. L. Bor, Deputy Conservator of Forests, have now been finally printed.

Mr. Mackarness's Working Plan for the Hill Forests of Lakhimpur and Sibsagar Divisions is at present being printed.

Mr. C. S. Purkayastha, A.F.S., acted as Working Plan Officer during the year.

In addition to completing the field work of the Working Plan for the Plains Forests of the Lakhimpur Division, Mr. Purkayastha submitted his Preliminary Working Plan Report for the *hollock* (*Terminalia myriocarpa*) and other forests of the Sadiya Frontier Tract Division. The latter was forwarded to and received back from the Forest Research Institute with criticisms during the year.

The Working Schemes for one Reserve in the Khasi and Jaintia Hills and for 6 Reserves in the Garo Hills have been sanctioned during the year. The Working Scheme for the North Kamrup Reserve is still under consideration.

The Kamrup, Goalpara and Shillong Working Plans and the Working Plan for the Hill Forests of Lakhimpur and Sibsagar Divisions have been introduced. It is feared that the present general depression both in the timber trade and in the finances of Government will render the proper working of these Plans extremely difficult. The proposal to convert timber in the forests in the District of Cachar mentioned in last year's report had to be dropped owing to the general depression in the timber trade in the Valley.

The Working Scheme prepared for the Cachar Forests has now been definitely abandoned and the leases issued under it have been cancelled. The serious floods in 1929 combined with the big slump in the timber market since that year has rendered the terms and conditions of the old leases too severe and they have been replaced by new leases which give the traders more latitude.

(ii) *Yield Tables.*

All sample plots are maintained.

(iii) *Volume and Form Factor Tables.*

A local volume table for *al* is published in Kamrup, Goalpara and Shillong Plans. The volume is given in commercial timber as estimated by the Working Plan Officer.

BENGAL.

I.—EXPERIMENTAL SILVICULTURE.

(i) General.

Mr. H. G. Champion, Central Silviculturist, toured Northern Bengal from the 13th to the 24th January 1932.

Work was carried out in both Northern and Southern Ranges in accordance with the programme of work laid down.

(ii) Natural Regeneration.

(a) *Sundarbans species*.—Experimental Plot Nos. 3 and 4 which were fenced against deer were inspected. The object of the plots was an ocular comparison with their surrounds to see if by excluding deer regeneration of the more important species could be obtained. The results have passed all expectations and the plots were found to be full of young regeneration of *sundri* (*Heritiera fomes*), *gungwa* (*Excaccaria agallocha*), *amur* (*Amoora cucullata*), *khalshi* (*Aegiceras majus*), *dhundal* (*Carapa obovata*) and *goran* (*Ceriops roxburghiana*), the last two being most conspicuous as regeneration of both is common in the plots but seldom found in the forest. No seedlings of *keora* (*Avicennia officinalis*) have been found although large mother trees constitute the dominant canopy. As this species is a purely transitory crop, it would appear that it does not regenerate itself naturally on the same area as the mother trees. On examining the surrounds it was seen that beyond a few seedlings of *sundri*, regeneration was absent. The one difficulty in the upkeep of these plots is that saline water rots the wire.

(b) *Dipterocarpus spp.*—All the experimental plots (except Nos. 1, 5, and 6 abandoned during 1930-31) at Bhomaringhona in Cox's Bazar Division were maintained. Besides, two new plots (Nos. 11 and 12) were laid out, the object being the same, that is, to discover a method of obtaining regeneration of *Dipterocarpus turbinatus* and *D. costatus*, either naturally or by natural-cum-artificial methods. There is little to note this year in these plots, and work was carried out and observations taken on the lines mentioned in last year's report. The work and results obtained in E. P. No. 10 are worthy of note. In January 1931, the undergrowth was cut, and slash left *in situ*, and the middle storey was thinned (cut and girdled) to let in more light. Slash was burnt before seed-fall, care being taken to protect the seed-bearers. The remainder of the miscellaneous species in the second storey were girdled in May. In the eastern half, sub-plot A, *Dipterocarpus turbinatus* seeds were sown by notching (a new process, which consists of making a hole in the ground with the point of a *dao*, placing the seed

in the hole and just covering the seed with earth). In the western half, sub-plot B, seed was sown broadcast without hoeing.

In February 1932, an enumeration of seedlings was made, and it was found that the result of notching in sub-plot A, had been attended with phenomenal success and 2,197 healthy and vigorous seedlings of *Dipterocarpus turbinatus* were found, with an average height of 1 ft., whereas in sub-plot B—sown by broadcasting without any soil preparation—only 10 *D. turbinatus* seedlings were found. It would appear that the seeds sown in sub-plot B by broadcasting only, had dried up, it being a particularly dry year, and so no germination had taken place, and that in sub-plot A (notched area) the covering of the seed with earth was sufficient to preserve the vitality of the seed until the break of the rains. The notched portion will be watched with great interest.

(c) *Evergreen forests of the Kasalong Reserve, Chittagong Hill Tracts Division.*—Experimental Plots Nos. 4, 5, and 6 were maintained and observations made.

Experimental Plots Nos. 10 to 17.—A large block of about 50 acres (excluding swamps, known as *dhepas*) was laid out in the cold weather of 1930-31 and sub-divided into a series of plots (Nos. 10 to 17), each of about 5 to 7 acres in extent. The operations carried out in each plot were described in last year's annual report. The following work was carried out during the year under review. In most of the plots the original work of felling the different storeys was carried out in groups only. This year in all such plots these groups were joined up so as to make one uniform treatment throughout each plot. Two observations were taken during the year.

It is too early yet to note any appreciable difference as a result of each kind of treatment and ocular observations over such large areas cannot be depended upon. It was, therefore, considered necessary to lay out a series of Indicator Plots for detailed study. Accordingly, in March 1932, diagonal Indicator Plots 6 ft. in width were laid out and demarcated, one in each Experimental Plot, and these will be maintained all through. In each of these Indicator Plots seedlings and saplings of valuable species have been enumerated in $\frac{1}{4}$ inch diameter classes and stocking and its density indicated on a map. Position of mother trees has also been marked in some of these plots. Some of the seedlings in the Indicator Plot have been numbered by tying small tin plates. The heights of these numbered seedlings will be taken periodically so as to note the rate of growth under each method of treatment.

As 1931 was a particularly bad seed year for almost all species, there could not be any appreciable increase in the recruitment of seedlings during the past year.

(d) *Hopea odorata*.—The two interesting patches of *Hopea odorata* regeneration adjoining the 1930 plantation at Hazarikhil, Chittagong Division, were kept under observation as E. P. Nos. 9 (a and b). In 9 (a) the overhead canopy was opened up by removal of all bamboos and most of the tree species so as to let in more light. In 9 (b) only the undergrowth was cut so as to free the seedlings but the overwood was not interfered with. From observations taken it was seen that the plants in 9 (a) were larger than those in 9 (b).

(e) *Shorea robusta* (Experimental Plot No. 16 of Buxa Division). Last year's experiment on the method of obtaining natural reproduction of *sal* by burning as practised in Assam was carried out at Santrabari. As a result of last year's burning of the debris, the area was again covered with a dense growth of *sau* grass (*Pollinia ciliata*) about 4 ft. high, and underneath this grass a fair number of *sal* seedlings made their appearance. Results of enumerations in 2 lines 210 ft. long and 6 ft. wide running through an average area showed that in such a line the number of *sal* seedlings averaged 20. This year attempts were made to burn the area in February, again in March and thirdly in the 1st week of April, but even in the end burning was not very complete and thorough. Dense *sau* grass appears very difficult to burn, and burning must be done as late as possible.

(f) *Experimental Burning Plots in the Bhabar Tracts at Raimatong*.—Burning in the *bhabar* tract areas at Raimatong in the Buxa Division was continued by the divisional staff. The condition of the *sal* seedlings and undergrowth is more or less the same as was noted last year.

(iii) Seeds.

(a) Seeds of exotic species for experimental purposes and seeds for plantations were supplied to divisions through the Silvicultural Division.

(b) Samples of seeds of 27 different species were supplied to Japan.

(c) Seeds of the following valuable timber species for experimenting with at higher elevations in the hills were supplied by the Forestry Commission in England and the Research Station in Japan:—*Fagus sylvatica*, *Picea excelsa*, *Pinus murrayana*, *Abies veitchii*, *A. grandis*, and *Alnus incana* from England; and *Pinus thunbergii* from Japan.

(d) Germination tests of the following species were carried out in wooden boxes under shade at an elevation of 6,500 ft. with the following results:—

Species.	Time taken to germinate.	Percentage.
<i>Cupressus torulosa</i>	1 month .	46
<i>Pinus khasya</i>	1 month .	60
<i>Pinus excelsa</i>	1 month .	48

(iv) *Nursery Work.*

(a) The Silvicultural Nursery and Garden at Hazarikhil, Chittagong Division, Southern Circle, were maintained during the year. Observations continued to be taken on species sown last year and mentioned in last year's report. In addition further repetitions were made and also experiments with species taken up. The Silvicultural Garden at Hazarikhil was maintained and experiments to compare the results of direct sowing, transplanting and root-and-shoot planting were laid out for the more important species indigenous to the Chittagong District.

(b) A permanent silvicultural nursery and garden under the control of this Division was laid out at Sukna, Kurseong Division. Experiments were carried out to find the best method of artificial regeneration of species suitable to the plains of Northern Bengal.

(c) A silvicultural nursery was maintained at Hum in the Darjeeling Division for experiments with hill species.

(d) A creeper nursery was laid out at Sukna by Mr. D. A. G. Davidson, Divisional Forest Officer, Kurseong Division, in order to study the times of flowering and fruiting, methods of propagation and control of the more common creepers found in plantations. Creepers were uprooted in the plantations and transplanted in the nursery both under shade and in the open.

(v) *Artificial Regeneration.*

(a) Regular and *taungya* plantation in the Chittagong and Cox's Bazar Divisions.

Out of the 7 Garden Plots maintained in the Cox's Bazar Division since 1928-29, 4 were abandoned in January 1931, but 6 more plots were added during the year under report. In the Chittagong Division 4 Garden Plots were maintained. The object of all these plots was to discover the best method of treatment of *bogamedcloa* (*Tephrosia candida*) in relation to *gurjan* (*Dipterocarpus* spp.), both for keeping down weeds, as well as for affording shade as a nurse crop, without at the same time interfering with the growth of *gurjan*.

It is not necessary to detail these plots here. An important point discovered this year was that in the 3rd year *bogamedcloa* pruned in June coppiced very badly and Assam *Iota* (*Eupatorium* spp.) soon got the upper hand, whereas that coppiced in May responded immediately and weed-growth was kept in check.

The following is a summary of observations and conclusions arrived at up to date.

The best treatment that will suit both the *bogamedcloa* and the *gurjan* with the primary object of establishing the latter still remains

an open question. Our experiments, extending over a quinquennium, and frequent observations in the three Chittagong Divisions have led us to certain definite conclusions. A shade or cover crop like *bogamedeloa* is essential for the purpose of affording shade to the *gurjan* for its first 2 or 3 years in order to prevent it being dried up during the hot weather, and also to help to keep down Assam *lota* until the *gurjan* is established. The value of *bogamedeloa* as a preventor of weed-growth cannot be questioned, and if a dense crop of *bogamedeloa* is required it can be coppiced back for several years in succession, provided always that the stumps are cut over a little higher up in each subsequent year.

It has also been recognised that although *gurjan* requires some sort of shade for protection against being dried up by the sun during its first two hot weathers, at the same time, it certainly grows better in the light, and whenever light is let in either from the side or from overhead, its growth is much more vigorous than in the shade. It can, however, persist under shade apparently indefinitely in a suppressed condition.

As the result of observations and experiments made during the last 5 years, the following is the programme now laid down by the Divisional Forest Officer, Cox's Bazar Division, in his regular plantations. Here the problems are simpler than in *taungya* plantations, as there are no field crops to consider and *bogamedeloa* can be put out at the same time as *gurjan*.

1st Year—

March	Cleaning and burning.
March to May	Hoeing done gradually all over the area.
May to June	Sowing of <i>gurjan</i> seed.

Dipterocarpus turbinatus is found to be the most suitable of the *gurjans* as the seed is ripe just at the break of the rains which is not so with the other species, and also its germination percent is usually from 80 to 90, whereas *D. costatus* gives only 25—30 per cent., and *D. alatus* even less. Sowing is usually started in the last week of May and continued up to the middle of June. The middle fall of the seed is considered the best. All seed is examined for the presence of grubs, whose outward sign is a blob of gum on the seed. Seeds are sown in lines 6' apart, 3 rows of seed to a line. Seed is notched and covered with earth, the wings being exposed.

Bogamedeloa is sown in the beginning of May. In the cooler north and east aspects and on lower slopes where the growth of *bogamedeloa* is good, it is sown thickly in lines 1' wide running centrally between the *gurjan* lines. In exposed south and west aspects and on the high ridges, where its growth is poor, it is sown broadcast right up to the *gurjan* lines.

July to August.—Cleaning done. Any *bogamedeloa* found in the *gurjan* lines are pulled up. Climber pulling instead of climber cutting will in future be carried out in all cleanings.

2nd Year.—May to June. Cleanings. *Bogamedeloa* is thinned wherever it is found thick. This includes lopping of side branches overtopping the *gurjan*.

3rd Year.—May. Cleanings. In the cooler north and east aspects and on lower slopes where the growth of *bogamedeloa* is very thick, it is pruned 6" below the height of the *gurjan* plants. In dry exposed south and west aspects and on higher ridges *bogamedeloa* is not pruned unless it is found to be overtopping the *gurjan*, in such areas its growth is usually poor and it seldom overtops the *gurjan*.

4th Year.—May. Cleaning. *Bogamedeloa* is cut out as the *gurjan* will by then be fully established, and *bogamedeloa* also loses its power of reproduction.

In *taungya* plantations the problem of combining shade crops and field crops still presents considerable difficulties. The best time to sow *bogamedeloa* appears to be in the middle of July, immediately after the last cleaning to the field crop. It must be sown broadcast thickly after scratching up the earth. Any blanks can be filled up by sowing in September. Experiments are being laid out this year at Hazarikhil in the Chittagong Division to ascertain the best time and method of sowing in *taungya* plantations.

(b) *Cover crops.*—(i) *Phascolus calcaratus* (*mashyam kalai*), *Leucaena glauca* and *Clerodendron infortunatum* (*blant*) were tried in the silvicultural nursery and garden at Sukna. The experiments were laid out with the object of finding an alternative to *bogamedeloa* (*Tephrosia candida*) as a cover crop for keeping down weeds and climbers. *Bogamedeloa* is not an easy crop to treat; its growth is extremely rapid and unless carefully watched, it is apt to suppress the young *sal*. Also as its growth is so rapid, it cannot be put out in the 1st year at the same time as the *sal*, as experience has shown that it suppresses the *sal* and practically kills it out. This is a distinct disadvantage in regular plantations where no field crops are raised. *Phascolus calcaratus* plants were all eaten up by deer and would not therefore appear to be suitable. *Leucaena* and *Clerodendron* show distinct possibilities and experiments on larger scale with these two species will be carried out this year.

(ii) *African and Napier grass.*—Root-suckers of the above were planted in the 1931 plantations at Bhomariaghona in the Cox's Bazar Division and Kaptai in the Chittagong Hill Tracts Division in between the lines of plants with the object of keeping down weeds and acting as a shade to the young *gurjan* plants. Those of the African grass failed while the Napier grass has done quite well. Napier grass is being experimented with again this year in the 1931 plantation at Sukna.

(vi) *Reclamation and Afforestation.*

Nil.

(vii) *Thinnings and Cleanings.*

(a) *Thinnings.*—A further 3 sets of three plots each to study different grades of thinnings were laid out in the 1926 *sal* plantations at Kuntimari, Jalpaiguri Division, and at Nimati and Kodalbasti in the Buxa Division.

(b) *Controlled burning in sal plantations.*—The plots mentioned in last year's report laid out to observe the effects of changes in undergrowth and cost of climber cutting by controlled burning in *sal* plantations were maintained, and observations recorded. In addition, two further sets were laid out at Dalgaon in Jalpaiguri Division and Nimati in Buxa Division. There are now altogether 8 sets, and these cover all types of *sal* plantations from the comparatively dry plantations of Sukna and Tarkhola, to the extreme evergreen of Rajabhatkhawa and Nimati in Buxa Division. There is no doubt that in all cases, even after one burn, the evergreen undergrowth is changing. In Experimental Plot No. 14A, situated at Rajabhatkhawa, one of the first plots laid out, the change in undergrowth is remarkable. This plot has now been burnt for three years in succession. When the plot was laid out in 1929 the undergrowth was extremely dense, about 4 ft. high, and it was practically impossible to force one's way through it. When inspected in January 1932, the evergreen undergrowth had practically disappeared and *sau* grass (*Pollinia ciliata*) had taken its place.

All the plots were examined in April 1932, a few weeks after burning, and it was noticed in every case in the burnt areas that the *sal* saplings were bare of leaves and that they had not got their new flush, whereas in the unburnt plots the young saplings had all got their new flush of leaves. How much this will affect the increment of the crop can only be found out at the time of remeasurement of the plots. *Sal* in the plains of Bengal begins to get its new leaves about the 3rd week of March. It would appear that every effort must be made to burn plantations before the 2nd week of March, that is, before the new flush of leaves has appeared.

In Experimental Plot Nos. 5, 5A of Jalpaiguri Division, the undergrowth at the time of laying out consisted mostly of thatch grass. The fire this year was extremely fierce and the bark of the saplings was charred up to a height of 6' to 7'. It would seem obvious that this type of plantation should not be burnt, as such a fierce fire is bound to affect the growth of the *sal*. When this plot is remeasured it will be very interesting to compare the loss of increment in this extreme case with that of the unburnt plot.

There appears at present to be little difference, if any, in the cost of climber cutting between burnt and unburnt plots and the little saving that there may be, is spent in the cost of burning.

In Experimental Plot Nos. 3, 3A of Sukna, Kurseong Division, it was noticed that all the suppressed and badly dominated trees were dying out. This is probably due to the effects of burning.

(e) *Eradication of climbers in plantations.*—The Divisional Forest Officer, Kurseong Division, has opened 3 sets of Experimental Plots at Sevoke, Sukna, and Dauhara to study the best and cheapest method of eradicating climbers.

In one plot of each set all climbers were dug up and the roots and tubers removed. In the other plot no special treatment was carried out and it was used as a control. The idea being that by pulling up the roots of climbers in the first year of a plantation before they get a hold will reduce the number and cost of climber cutting in the future, especially in *sal* plantations which take longer to close up. It is too early to come to any conclusions and it is not expected that any real benefits will be noticed before the 5th or 6th year.

(viii) *Mixtures.*

Mr. Champion, the Central Silviculturist, after his visit to Northern Bengal this cold weather, pointed out the silvicultural undesirability of putting out plantations of pure crops, perhaps with the exception of *sal*, which is naturally found pure, and he suggested we should try some experiments with mixed crops. In view of this, and the recent heavy casualties to pure *champ* (*Michelia champaca*) plantations by the pest *Urostylis punctigera*, and to *gamari* (*Gmelina arborea*) plantations by *Loranthus*, it has been decided next rains to lay out a series of experiments with different types of mixtures. A scheme is now being prepared by the writer and the Central Silviculturist has been asked to express his views and give his advice.

Mr. N. Pal, Divisional Forest Officer, Chittagong Hill Tracts Division, has in his 1931 plantations started a series of experiments with different methods of mixing *gamari* and mahogany (*Swietenia macrophylla*), the results of which will be watched with interest.

(ix) *Underplanting.*

(a) The experimental plots at Rajabhatkhawa, Buxa Division, in underplanting *Chickrassia tabularis* with *Michelia champaca* and *Shorea robusta*, laid out in 1925 have been kept up. *Sal* is very whippy and does not seem to be growing much. *Champ* plants appear now to be doing better. The following table gives for comparison the height

increment of these underplants with the same species of the same age grown in the open :—

Species.	Height in the open of the same age.	Height of the underplant under <i>Chickrassia tabularis</i> .
<i>Shorea robusta</i> . . .	Best 26'-0" . . . Worst 13'-0" . . . Average 20'-0" . . .	Best 8'-0". Worst 3'-0". Average 6'-0".
<i>Michelia champaca</i> . . .	Best 38'-0" . . . Worst 24'-0" . . . Average 31'-0" . . .	Best 27'-0". Worst 6'-8". Average 17'-0".

The above results show that *champ* is doing fairly well as an under-plant, but *sal* is disappointing.

(b) Experiments in underplanting and under-sowing in the three Chittagong Divisions mentioned in last year's report were continued. Under this heading 3 plots were abandoned and 4 added making a total of 11 plots maintained up to the end of the year. Of the species tried up to the present *Dipterocarpus turbinatus*, *Dichopsis polyantha*, *Swietenia macrophylla*, *Artocarpus chaplasha* and *Bambusa tulda* appear to be the most suitable for underplanting and sowing. Poor results have been obtained with *Dipterocarpus costatus* and *Lagerstroemia flos-reginae*.

(x) Miscellaneous.

(a) *Co-operative investigation on the origin of Teak Seed*.—This all-India investigation was taken up at Kaptai, Chittagong Hill Tracts Division, and seed from Bombay (moist and drier types), Madras (Nilambur), Burma (northern and southern types) and Chittagong Hill Tracts were used. Owing to very irregular germination of some origins, results have not been very satisfactory and arrangements are being made to fill up all blanks during 1932-33.

(b) *Root-and-shoot-cutting experiments*.—*Experimental Plot No. 9* (Chittagong Hill Tracts Division). An area of about an acre in the 1930 plantation at Kaptai was planted up with root-and-shoot-cuttings towards the latter part of July 1930. The experiment was intended to study if propagation of teak by this method of stump-planting is harmful, and if such plants are liable to develop rot.

The Central Silviculturist suggested "the necessity of raising with the cuttings, plants from sowings and from transplants with which to compare the cuttings". Towards the end of the year under report the above plot was abandoned, as there was no comparison with transplants. Now plots will be laid out this year in the 1932 plantation at Kaptai to repeat the experiment on the lines suggested by the Central Silviculturist.

(e) *Experimental Plot No. 15 (Bura Division).*—This Experimental Plot mentioned in last year's report, laid out to see if young *sal* will be affected by the fungus *Polyporus shoreæ* that killed the old trees on the same area, was inspected and no sign of any fungus was noticed and seedlings looked very healthy.

(d) *Loranthus attack in gamari plantations.*—In the subsequent history of Experimental Plot No. 1, Chittagong Division, it was noted on the 22nd August 1930 "that the *gamari* overwood has been attacked by *Loranthus*, and a number of *gamari* trees were looking unhealthy".

Since then the incidence of this pest has been enormous and on visiting Kaptai plantations in the Chittagong Hill Tracts Division in February 1932 it was found that young *gamari* plantations of all ages except 1929 and 1930 had been affected and that the pest is extremely serious. In the 1923 plantation up to 60 per cent. of the trees had been attacked and many were already dead. A few *jarul* (*Lagerstræmia flos-reginæ*) had also been attacked. Nor has this pest confined itself to plantation-grown *gamari*, and Mr. J. N. Sen Gupta, Assistant Silviculturist, has noticed isolated *gamari* trees in *jote* lands outside the Reserve at Hazarikhil in Chittagong Division, equally (or perhaps more) affected.

(e) *Tali-fungus.*—In February last a few *tali* (*Dichopsis polyantha*) plants in the Silvicultural Garden at Hazarikhil were noticed to be dead and dying and a fungus was suspected. Accordingly, a few plants were dug out and sent to the Mycologist, Delhi Dun, whose reply may be quoted "The diseased specimens of *Dichopsis polyantha* were examined and appear to have been killed by some fungus pathogen. The surface of the root is covered with a fungus, apparently of a saprophytic nature, and at the collar region a white fungal growth was observed which was found to be a species of *Fusarium*. An effort to isolate the pathogen in its purest form proved futile."

(f) *Urostylis punctigera.*—Most of the *champ* (*Michelia champaca*) plantations of all ages in Northern Bengal have been attacked by the above pest. In some cases the attack has been extremely severe, and in the 1926 plantation of Garalduba, Jalpaiguri Division, many trees have been killed outright in one year's attack. The pest is not selective and when an attack is noticed in a plantation, all the trees are found to be affected. Pure *champ* plantations will have to be stopped until the effects of this pest can be gauged. It is hoped that the Forest Entomologist will be able to come to Bengal and instruct and advise us on suitable methods of prevention or cure. *Champ* timber is about the most valuable of the species put out in plantations in the plains of Northern Bengal, and it will be a great pity if this species cannot be put out any more.

(g) Specimens of roots of *Chickrassia tabularis* and *Cinnamomum cecidodaphne* found to have been killed by fungus in Sample Plot No. 6-

at Rajabhatkhawa, Buxa Division, were sent for identification to the Forest Mycologist, Dehra Dun.

II.—WORKING PLANS AND STATISTICS.

(i) Working Plans.

(a) The 4th Working Plans for the Jalpaiguri and Buxa Divisions received sanction by Government during the year and are now in operation.

(b) *Control Forms*.—Control forms 2 and 4 of all divisions were checked by the Silviculturist. This takes up a considerable amount of his time which could be well employed on his own work. It is hoped that if a Working Plan Officer is appointed, the checking of Control Forms will be handed over to him.

(ii) Yield Tables.

While remeasuring the Linear Sample Plots identifications of hitherto unknown species were made and wrongly identified ones corrected. Some unknown species were sent to Dehra Dun and have been identified. Mr. Parker, the Forest Botanist, Dehra Dun, visited these lines during the year and has since identified unknown trees of which flowering specimens could be obtained.

One new Linear Sample Plot was laid out at Samsing, Jaldhaka Range, Kalimpong Division.

Ring counting and stem analyses.—Stem analyses of the following species grown in the high forests and apparently of dominant canopy were carried out during the year. After collecting the necessary data, curves showing height, diameter, and volume over age, will be prepared and preserved in the office for comparison with curves obtained from Sample Plots of the species grown in the plantations and high forest.—

Division.	Locality.	Species.	Number of trees.
Darjeeling	Rangirum	<i>Cupressus funebris</i>	2
	Rangirum	<i>Picea cretata</i>	1
	Lopchu	<i>Juglans regia</i>	1
	Takdali	<i>Cryptomeria japonica</i>	2
	Rangirum	<i>Cryptomeria japonica</i>	4
	Rangirum	<i>Alnus nepalensis</i>	2
Kurseong	Lopchu	<i>Alnus nepalensis</i>	1
	Bagora	<i>Alnus nepalensis</i>	2
	Dowhill	<i>Cupressus funebris</i>	1
Kalimpong	Samsing	<i>Dyabanga sonneratioides</i>	2
Sundarbans	SipsaCoup	<i>Heritiera fomes</i>	2

Larger files.—At the close of the year there were 151 Specific and 82 General Ledger Files maintained in the office.

BIHAR AND ORISSA.

I.—EXPERIMENTAL SILVICULTURE.

(i) *General.*

The post of the Forest Research Officer was held by Mr. L. R. Subharwal, Deputy Conservator of Forests, until the 2nd December 1931 when Mr. B. P. Basu, Working Plans Officer, took over charge of the Research Division in addition to his own Working Plans duties. In view of the present need for economy it was decided to amalgamate the Working Plans and the Research Divisions. Consequently the Research Programme had to be revised. The programme of research work in the divisions has been so revised that it has now been possible to arrange the divisions into two groups so that in future the Forest Research Officer will tour in alternate years in each of the two groups. As a result of this arrangement the maintenance of Sample and Experimental Plots and the carrying out of such operations as felling of underwood, clearing of undergrowth, burning, hoeing or ploughing, etc., in the Experimental Plots which has hitherto been done by the research staff has now been relegated to the Divisional Staff. Only the statistical part of the work together with any enumeration and thinning that may have to be done will be carried out by the Research Staff. The staff of the Research Division has, therefore, been reduced to one Forest Ranger only. This revision of the programme will in the first instance necessitate re-measurement of some of the Sample plots a year before or after the fixed interval of 5 or 10 years as the case may be. There does not seem to be any objection to this provided that the revised programme is rigidly adhered to in future.

The Ranchi Air Seasoning shed has now been abolished and the plant has been sold off.

The problem of co-ordinating Experimental plots has continued during the year. A few of the Experimental plots were abandoned. The reasons for abandoning the plots were either that accidents had upset the initial conditions of the experiments or that they had given definite results.

According to the programme the Forest Research Officer toured in Sambalpur, Angul and Puri Divisions.

The files of the Research Office were re-classified according to the revised heads adopted by the Central Silviculturist.

Considerable additions have now been made to the collections in the Museum started last year in the Forest Office building at Ranchi.

(ii) *Experimental work.*

The important results arrived at during the year were as follows :—

- (a) The experimental plots in the dry type areas of the Sambalpur Division (Plots Nos. 2 and 3) tend to show that so far as *sal* (*Shorea robusta*) seedlings in these areas are concerned 1'-9" is too low a height at which the seedlings may be considered to be established.
- (b) Observations in Experimental Plot No. 15 in the same locality have shown that the most vigorous coppice shoots are usually produced by *sal* trees of 4" to 12" in diameter. This has got an important bearing on the subject of "Cleaning operations" to be carried out after the main fellings inasmuch as the coppice shoots from younger trees should be favoured against those from older trees.
- (c) It is now concluded from the two sets of experiments carried out again in the Sambalpur East Division (Experimental Plots Nos. 7, 8, 28 and 29) that in dry type areas burning the coppice coupes after clear-felling does not stimulate the stools to increased growth or number of coppice shoots as believed hitherto.
- (d) To test on the growing season of *Casuarina equisetifolia* two experimental plots were laid out in a one-year old plantation, one in a water-logged area and the other in a somewhat drier type of area. Experiments show that although growth in the water-logged areas is very much slower than the growth in comparatively drier types from about the middle of October till the end of April, the growth in the former area is somewhat faster than in the latter from the end of April till the middle of October.

(iii) *Natural Regeneration.*

The *sal* forests in this province are mostly in unstable equilibrium. Amongst other things fire protection seems to have contributed principally to this state. The natural regeneration experiments in this province have therefore been directed mainly towards this factor. Systematic investigation was started only recently but from the old experimental records the following *ad interim* observations have been made :—

- (i) Complete fire protection in dry type areas tends to induce *sal* regeneration where it is absent; it has also got beneficial effect on the establishment of the natural regeneration.

- (ii) Continuous burning in damp type areas seems to be favourable for self regeneration by changing the character of undergrowth.

But it seems that the most difficult damp type areas in this province have advanced too far in the direction towards the higher plant association and it seems doubtful if burning in these areas will have a direct influence in bringing about the natural regeneration.

It will be interesting to note here that in somewhat damper valleys in Angul where oil is the principal crop in the upper story it seems possible to regenerate the areas naturally by means of carrying out judicious fellings of overwood followed by repeated cleanings and creeper cuttings.

(iv) *Nursery Experiments.*

The experimental garden at Hinoo was maintained as usual and the germination capacity of various species was tested in the Nursery. Germination percentage of some of the more important species with which we are concerned in this province is tabulated below :—

Germination percentage of important species tested at the experimental garden, Hino.

Species.	Origin of seed.	Date of sowing.	Nature of bed.	Germination per cent.	REMARKS.
1. <i>Shorea robusta</i>	Ranchi	25th June 1930	Flat bed with farmyard manure of 9 tons per acre.	Per cent. 20	Seed from old trees over 5'-6" girth.
Do.	Do.	Do.	Do.	43	Seed from crooked trees.
Do.	Do.	Do.	Do.	36	Seed from young trees 2'-3" girth.
Do.	Do.	21st June 1930	Raised bed	72	Seed from crooked trees.
Do.	Do.	25th June 1930	Ploughed lines 1' deep 2' broad.	24	Seed from old trees.
Do.	Do.	Do.	Do.	45	Seed from crooked trees.
Do.	Do.	Do.	Do.	38	Seed from young trees.
Do.	Do.	21st June 1931	Dug up lines in unploughed land.	66	Lines sown with <i>Tephrosia candida</i> .
Do.	Do.	Do.	Dug up lines in ploughed land.	49	Do.
Do.	Do.	Do.	Do.	30	Lines without <i>Tephrosia candida</i> .
Do.	Do.	23rd June 1931	Lines 1' deep 2' broad	34	Soil mixed with lime and ploughed.
2. <i>Schleichera trifuga</i>	Choubassa	5th July 1931	Raised bed manured	15	
Do.	Palamau	18th June 1931	Flat bed manured	15	Seed dried under shade for 1 week.
Do.	Do.	Do.	Flat bed unmanured	8	Do.
Do.	Do.	23rd June 1930	Flat bed manured	25	Do.
Do.	Do.	27th June 1930	In the pots manured	30	Do.
Do.	Choubassa	10th April 1931	Sunken bed manured	36	Seed soaked in water for 12 days.
Do.	Do.	30th March 1931	Do.	43	Seed soaked in water for 72 hours.
Do.	Do.	Do.	Unseeded bed manured	8	Do.
Do.	Do.	27th March 1931	Shaded bed manured	14	Do.
Do.	Do.	Do.	Sunken bed manured	8	No treatment to seed.
Do.	Do.	Do.	Shaded bed manured	22	Do.
3. <i>Eugenia jambolana</i>	Ranchi	25th June 1930	Flat manured bed	6	After removing the pulp.
4. <i>Dendrocalamus strictus</i>	Palamou	21st July 1931	Do.	80	Germinated from seed.
Do.	Forahat	3rd July 1930	Do.	80	Do.
Do.	Hinoo	26th July 1930	In lines 6' deep 2' broad	25	1 year old culm offsets with 2 internodes and young branches, the middle portions of culms only being used.
Do.	Forahat	2nd July 1930	Do.	80	Old bamboo rhizomes with 1' bamboo.
Do.	Do.	Do.	Do.	20	Offsets of lower portions of bamboo, each offset with 2 internodes and eyes.
Do.	Do.	7th July 1931	Do.	30	Cuttings of top portions of old bamboos with 2 or 3 internodes just below the whippy tops.
Do.	Do.	20th July 1931	Do.	20	Offsets of middle portions with holes of the nodes.
5. <i>Pterocarpus marsupium</i>	Saranda	5th May 1931	Sunken bed manured	12	No treatment to seed.
Do.	Do.	5th July 1931	Raised bed manured	22	
Do.	Do.	22nd June 1931	Lines 1' deep 2' broad	2	Land ploughed with lime.
Do.	Puri	23rd June 1931	Do.	2	Do.
6. <i>Tectona grandis</i>	Palamau	11th May 1931	Sunken bed and manured	4	Soaked in water and crowding for 10 days.
Do.	Burma	26th April 1931	Do.	20	Soaked in water for 30 days.
Do.	Do.	3rd April 1931	Do.	31	Soaked in sulphuric acid for 15 minutes and washed for 3 days in water.
Do.	Angul	Do.	Do.	80	Soaked in crowding for 7 days.
Do.	Burma	Do.	Do.	21	Do.
Do.	Puri	Do.	Do.	4	Do.
Do.	Burma	23rd June 1931	Lines 1' deep 2' broad	7	Land ploughed mixed with lime.
Do.	Do.	22nd June 1931	Do.	7	Land unploughed but lime spread.

It will be interesting to note :—

- (i) that germination per cent. of *sal*-seed is independent of the quality of the trees from which they are collected ;
- (ii) the best result in forest conditions may be obtained by sowing *sal* seed with *Tephrosia candida* in dug up lines.

The bamboo experiments show (i) that it is quite easy to raise seedlings in nurseries in manured beds and the success obtained may be as much as 80 per cent.; (ii) the best way of artificially regenerating bamboos is to plant old culms with rhizomes.

As regards the teak seeds, the experiments with Burma seed are most disappointing. We have never been able to get more than 31 per cent. of germination and that even by soaking the seed in sulphuric acid for 15 minutes. The local seeds have given very much better germination and we have now decided not to obtain any more seed from Burma.

The experiments in Palamau show that small entire teak transplants are almost certain to fail ; larger entire transplants give fair results ; while a high percentage of success may be expected from the use of old root and shoot cuttings. The real problem to be solved now is to obtain quick germination of local seed so that seed sown at the end of the hot weather will produce sufficiently large transplants to be put out as root and shoot cuttings in the rains of the following year.

(v) Artificial Regeneration.

From the experiments concluded at Sambalpur (in Experimental Plot Nos. 6, 13 and 14) it is evident that the best way of afforesting abandoned paddy fields is by transplanting *Terminalia tomentosa* and *Eugenia jambolana* on mounds.

Seed of *Dolichandrone platycalyx* was obtained from Uganda and sown in the Betla nursery, Palamau. Germination was excellent. The plants left in the nursery showed rapid growth and if the plant, when transplanted, can pull through the hot weather when it is young, it may prove a very suitable species for stocking blanks in coppice forest.

The following species were tried in the *Casuarina* plantation in Balukhand, Puri :—

1. *Eucalyptus rostrata*.
2. *Grevillea robusta*.
3. *Melaleuca leucadendron*.
4. *Careya arborea*.
5. *Eugenia jambolana*.
6. *Azadirachta indica*.
7. *Albizia lebbek*.
8. *Acacia catechu*.

} About 3 per cent. died.

} All surviving but *Albizia lebbek* shows very stunted growth.

It will be necessary to water these plants to help them through the hot weather months.

Acer negundo seeds were tried in the Hinoo Experimental Garden and about 90 per cent. success was obtained in germination.

Sabai plantations on a small scale were tried in Sambalpur, Santhal Pargannas and Palamau and they all show signs of success. It may be possible to expand this plantation in the near future, so as to reclaim eroded ravine lands on certain geological formations.

An area of 65 acres was planted up with teak during the year in the Puri Division.

Teak plantation was continued also in the Angul Division. Endeavours are being made to introduce *taungya* system of planting teak in Puri and Angul Divisions. It will take some time to popularise the system. One or two Forest Villages have also been established to this end.

(vi) Reclamation and Afforestation.

An area of 27 acres only was added to the *Casuarina* plantation in the Puri Division. This completes planting up of the area acquired by the Forest Department.

II.—WORKING PLANS AND STATISTICS.

(a) (i) Working Plans for the Angul and Puri Divisions were approved by the Government and are in the press.

(ii) Working Plans for the Sambalpur East and West Divisions were submitted to the Conservator of Forests, Bihar and Orissa.

(iii) Working Plans were under preparation at the close of the year for the Palamau and the Kolhan Divisions.

(b) *Volume Tables*.—Figures for compilation of local volume tables were collected in the Kolhan Division and sent to the Central Silviculturist for compilation of the tables.

(c) *Coppice coupe outturns*.—During the year more figures were collected in some of the divisions, but it is unfortunate that these data could not be used to compile coppice coupe outturn tables as the ages of the coupes where the measurements were taken could not be ascertained. They will however be useful in determining roughly the outturns from coppice coupes of similar felling series.

(d) *Kath heartwood outturn tables*.—Separate *kath* heartwood outturn tables were prepared for this province and published in the form of a Bulletin.

BOMBAY.

1.—EXPERIMENTAL SILVICULTURE.

(i) *General.*

The year opened with 18 subjects under investigation. Serial Nos. 27, 28, 30 and 35 gave results from which final conclusions have been drawn, while Serial Nos. 2, 29 and 31 were abandoned as there was no prospect of arriving at definite conclusions.

The work done, the results recorded, and conclusions arrived at are briefly described in the notes which follow.

(ii) *Natural Regeneration.**Sandal (Santalum album).*

Subject No. 28—Effect of early burning on sandal growth and regeneration (Belgaum Division).

In 1927 two sample plots were selected in the Khanapur Range of the Belgaum Division and all sandal trees in them enumerated by 1" girth classes in December of that year. In 1928 the investigation was taken on the files of the Research Branch of the Chief Conservator's office and directions were issued as to the manner in which it should be conducted during a period of 5 years commencing from the year the initial counts were made.

The plots were numbered 28-A and 28-B. The former was rigidly fire protected while the latter was subjected annually to controlled early burning and the trees in each plot were counted each year in December and reported as shown below :—

PERIODIC SUMMARY.

Experimental Plot No. 28.

MEASUREMENTS.											
Date.	3 to 4".	4 to 5".	5 to 6".	6 to 7".	7 to 8".	8 to 9".	9 to 10".	10 to 11".	11 to 12".	Over 12".	Total.
PLOT No 28-A (PROTECTED)											
December 1927	} 16	21	17	3	5	2	4	1	..	..	69
(March 1929)		..	..	..	..	..	..	..	..	..	..
December 1928		41	29	27	17	7	4	5	..	..	130
December 1929		68	36	29	20	10	8	6	1	..	172
December 1930		65	60	38	30	13	8	6	1	1	221
December 1931	81	66	54	30	17	6	6	1	1	262	
PLOT No. 28-B (EARLY BURNT).											
December 1927	} 70	79	41	31	14	6	5	..	..	..	252
(March 1929)		..	..	..	..	..	..	..	..	..	..
December 1928		66	99	49	27	14	6	2	1	..	284
December 1929		113	78	56	35	14	7	2	1	..	360
December 1930		121	94	70	48	25	12	2	1	1	385
December 1931	147	103	86	47	23	12	7	1	1	423	

The figures reported since 1928 are taken for drawing the following conclusions :—

- (1) that the fullest regeneration is obtained by complete protection from fire, but
- (2) that when soil, climatic and shade conditions are favourable early burning can be repeated year after year and yet a very satisfactory increase in regeneration may be obtained.

(iii) *Seeds.*

There is nothing of special interest to record except, as stated last year, that in most experiments connected with artificial regeneration a certain amount of data connected with germination percentage, survival percentage, aids to germination, etc., is collected and is available.

(v) *Artificial Regeneration.*

Teak (*Tectona grandis*).

Subject No. 2.—Germination tests of treated teak seed (Surat, Kolaba, Belgaum, West Khandesh, Panch Mahals and S. D. Kanara).

Teak seed, collected in one season from one and the same tree in each of the localities mentioned above, was treated in the manner shown below and experiments were taken in hand to determine the merits of each of the methods of treatment :—

- (1) Seed soaked and dried alternately 3 times, for a week at a time.
- (2) Seed soaked and dried alternately twice, for a fortnight at a time, and
- (3) Seed weathered in the rains and sown in the year following collection.

The results of seed treated according to methods (1) and (2) above were analysed last year and though the general mean average percentage of germination showed very little difference between the two methods of treatment, it was observed that the results obtained in the several divisions in which the tests were made varied very widely *inter se*.

This year the results of the experiments made with seed treated according to the 3rd method, owing to differences in the quantity and incidence of rainfall within the season, show such marked variations that they are not strictly comparable with the results obtained from seed artificially treated.

It is impossible from the information collected to draw any conclusion, and as there is no particular object in repeating the experiments this investigation has been closed.

Hirda (Terminalia chebula).

Subject No. 13.—Propagation of *hirda* (Poona and Satara Divisions).

It having been established that *hirda* stands transplanting and that a good percentage of success is obtainable, it remained to discover from what source seedlings for transplanting in the forest should be drawn. Experiments were ordered to be carried out with—

- (i) one year old natural seedlings ;
- (ii) one and half months old nursery seedlings ;
- (iii) natural seedlings of the year.

Last year the investigation could not be carried out as designed in its entirety and a repetition was ordered.

The results obtained are as under :—

*Hirda 1931-32.**Percentage of survival.*

Division.	SEEDLINGS OF		
	Class (i).	Class (ii).	Class (iii).
Satara	18	39.3	82.4
Poona	38.5	22.8	56.0
TOTAL	56.5	62.1	138.4
Mean	28.25	31.05	69.2

The indications are clear for both localities that natural seedlings of the year are the safest of the three classes to transplant and give promise of a satisfactory percentage of success. Also it is cheaper to use such seedlings, as the expense of making a nursery and watering is obviated.

The so called "one year old" natural seedlings cannot definitely be proved to be of that age. It also appears that natural seedlings are somewhat difficult to find, and for general propagation purposes it is necessary to maintain a nursery to supplement the natural seedling supply. Further experiments to find out the result of planting stumps cut from one year old nursery seedlings for transplantation in the forest have been ordered to be undertaken during the ensuing year. Stumps are to be cut and planted out in 1933 monsoon from seedlings to be raised in a nursery during the 1932 monsoon.

Anjan (Hardwickia binata).

Subject No. 27.—Reproduction of *anjan* by broadcast sowing, sowing in single plough drills and dibbling in patches in soils prepared according to different methods in closed and open forest. (East Khandesh Division.)

The treatments ordered and methods of sowing laid down were as follows in closed and open forest :—

Class of forest.	Method of sowing.	Soil treatment.
A		
1. Closed forest . . .	Broadcast . . .	Wounding the soil and mulching seedlings three times. Wounding the soil but no mulching. Soil to be ploughed in drills 10 feet apart and seedlings mulched three times. Soil to be ploughed in drills 10 feet apart but no mulching. Soil to be burnt in patches and seed dibbled 6'×6' and seedlings mulched 3 times. Soil to be burnt in patches and seed dibbled 6'×8' but no mulching.
2. Do.	Do.	
3. Do.	Sowing in single plough drills.	
4. Do.	Do.	
5. Do.	Dibbling	
6. Do.	Do.	
B		
1 to 6. Open forest . . .	a duplication of the	above.

A period of three years which terminates this year was fixed for the completion of the investigation. Operations commenced in 1929, but treatments 5 and 6 were not persisted in and consequently are eliminated from the summary of results. A comparison of the treatment 1 to 4 in closed and open forest respectively for the full period of 3 years is given below :—

Treatment.	PERCENTAGE OF SURVIVAL.							
	CLOSED FOREST.				OPEN FOREST.			
	1929.	1930.	1931.	Mean.	1929.	1930.	1931.	Mean.
1 . . . . .	..	88.1	80.6	56.2	68.8	55.2	51.0	58.4
2 . . . . .	..	94.6	84.3	59.6	41.4	70.1	57.5	50.3
3	17.7	34.4	21.4	24.5	24.5	70.0	28.6	41.0
4	51.0	31.1	18.1	33.7	7.1	61.3	27.3	31.9
Mean	17.1	62.3	51.0	..	35.3	64.1	41.3	..

From the above it emerges that both in open and closed forest ---

- (1) broadcast sowing is more successful than sowing in single plough drills ;
- (2) mulching exercises no particular influence on the percentage of survival.

The results obtained in open and closed forest run so close that it would appear that *anjan* does as well in either class of forest. It is noted that figures of cost were not collected, but as mulching is an expensive item and since it does not materially assist *anjan*, broadcasting after wounding the soil, without mulching the resultant seedlings, would appear to be the cheapest method of raising *anjan* artificially.

Safed musali (*Chlorophytum tuberosum*).

Subject No. 30.—Artificial propagation of *safed musali* (North Khandesh Division).

The results of two years' experiments to discover the best means of propagating *safed musali*, a valuable minor product occurring in North Khandesh, are summarised below. The investigation consisted of two methods of artificially raising the plant (sowing seed and planting out sections of tubers) in three different varieties of soils which are treated differently, as indicated in the summary :—

Safed musali—1929-30 and 1930-31.

Area of each sub-plot .125 acres.

KIND AND TREATMENT OF SOIL.			SOWING.				PLANTING.			
Main treatment.	Sub-treatment.	Kind of soil.	1929-30.	1930-31.	Total.	Mean.	1929-30.	1930-31.	Total.	Mean.
Ploughed	Burnt	Rocky	5.4	67.0	72.4	38.2	14.0	20.0	43.0	21.0
		Murum	0	15.0	15.0	7.5	43.0	26.0	74.0	37.3
		Black-cotton	0	43.0	43.0	21.5	31.6	44.0	76.0	37.8
Do.	Not burnt.	Rocky	10.5	73.0	83.5	41.7	13.0	27.0	43.0	21.0
		Murum	0.0	12.0	12.0	6.0	31.8	20.0	57.8	28.0
		Black-cotton	0	38.0	38.0	19.0	26.5	61.0	87.5	43.7
Not Ploughed	Burnt	Rocky	17.0	31.0	48.0	24.0	23.0	5.5	20.4	14.7
		Murum	8.3	19.0	27.3	13.3	32.3	22.0	54.3	27.1
		Black-cotton	0	38.0	38.0	19.0	26.7	41.0	70.7	35.3
Do.	Not burnt.	Rocky	14.5	21.0	35.5	17.7	32.0	0.3	32.0	16.4
		Murum	2.7	17.0	19.7	9.8	33.1	20.0	58.1	20.0
		Black-cotton	0	20.0	20.0	14.5	23.8	24.0	52.6	20.3

From the above the following general conclusions are drawn :—

- (1) Planting is more successful than sowing in all but rocky soils ;
- (2) Ploughing and burning black cotton soil tend to have a beneficial effect on the survival of shoots ;
- (3) In rocky soil sowing is attended by a fairly satisfactory measure of success.

Sandal (*Santalum album*).

Subject No. 35.—Artificial regeneration of sandalwood (Belgaum, Satara and Dharwar-Bijapur Divisions).

In last year's research report it was recorded that the experiments carried out in the Belgaum Division to discover the best method of raising sandal artificially indicated that—

- (1) dibbling seed gives better results than broadcasting, and
- (2) the optimum depth for dibbling is half an inch of soil cover.

As inconclusive results were obtained in Satara and Dharwar-Bijapur a repetition was ordered. Reports received show that the trials were vitiated in Satara by heavy and unseasonable rain and in Dharwar-Bijapur by the presence in the area, selected for the experiments, of regeneration sprung from seed as also by damage caused by rats and pigs.

In the Belgaum Division the attempt to raise sandal on a large scale artificially in combination with field crops has been very successful and tends to confirm the deductions drawn last year, *viz.*, that dibbling seed half inch below the ground is a sure method of reproducing sandal.

It has been decided not to carry out any further experiments.

Miscellaneous species.

Subject No. 29.—The value of shrubs as nurses for artificially raised seedlings in scrub forests (East Khandesh, West Khandesh and West Nasik Divisions).

The experiment has continued to yield quite inconclusive results and it has been decided not to carry it further.

Eradication of prickly pear.—On the suggestion of the Economic Botanist to the Government of Bombay, for the eradication of prickly pear, some cactus leaves covered with cochineal insects were obtained from Poona and tied to the leaves of prickly pear bushes in the Dharwar Range. The result is being watched.

(vii) *Thinnings and Cleanings.*

Subject No. 4.—The effect of thinning of teak coppice at different ages (East Thana Division).

The four plots laid out last year were maintained and steps were taken to lay out 4 additional plots to bring under observation a complete series of age gradations from 8 to 15 years.

Sandal.

Subject No. 7.—Annual girth increment of sandal (Belgaum and Dharwar-Bijapur Divisions). The second remeasurements of the trees in the 4 plots in the Belgaum Division were carried out in May 1931. From the measurements recorded up to date no deductions of any importance can be made.

Subject No. 32.—To discover whether there exists any correlation between outer girth increment and heartwood increment of sandal (Dharwar-Bijapur Division).

Two plots, one containing 50 trees in Tadas and the other 36 trees in Honkan, have been established and initial data recorded.

Re-measurements are placed at intervals of 4 years.

Babul (Acacia arabica).

Subject No. 8.—Increment of *babul* under different degrees of thinning [Hyderabad (Sind) Division].

The whole of the preliminary work in connection with the thinning of the various sample plots is now complete and the necessary data have been recorded.

The general conclusion arrived at in regard to the maintenance under observation of a series of sample plots in the *babul* areas of the Poona Division is that it is almost impossible to thin *Acacia arabica* too drastically so long as it is commenced early and continued at sufficiently short intervals.

II.—WORKING PLANS AND STATISTICS.

The following working plan was printed and sanctioned during the year :—

Working plan for the Scrub and Jamner Teak Reserves of the East Khandesh Forest Division.

BURMA.

SILVICULTURE.

(i) *General.*

Staff.—Mr. W. S. Shepherd, Deputy Conservator of Forests, was in charge of the division and U Sein Gyi, Extra Assistant Conservator of Forests, was attached to the division throughout the year.

The subordinate staff consisted of three Rangers, one Deputy Ranger, and ten Foresters.

Programme of work.—The programme of work was carried out as arranged, except that the rebellion in Lower Burma prevented the re-measurement and counting of sample and experimental plots in the Tharrawaddy and Zigon Divisions. It was necessary to re-measure certain plots in the Pyinmana, Katha and North Toungoo Divisions in advance because it would be impossible to cope with both the arrears from the year under report and the ordinary programme for 1932-33 in one year.

Preservation of groups of natural trees.—As a result of the resolution on item 22 of the programme of the Silvicultural Conference held at Debra Dun in 1929 an area of 10 acres of natural forest in the North Toungoo Division, Gwethle Reserve, parts of compartments 36, 37, 38 and 39 near Letpanpyu Rest House, has been set aside permanently as an example of teak (*Tectona grandis*) and *pyingado* (*Xylia dolabriformis*) forest with *kyathaung* (*Bambusa polymorpha*).

(ii) *Natural Regeneration.*

E. I. b and c. Dipterocarpus tuberculatus.—Experimental Plot 6, Yinke Reserve, Katha Division, clear felling, with and without fire protection, each counting plot one acre in area. An accidental fire in 1928 in the protected plot has spoilt this experiment as regards fire protection, but as regards the clear felling system it shows that there is a steady growth of the young in trees. The number of saplings 10' and over in height, per acre, has increased from 9 to 757 in the protected plot and from 10 to 384 in the burnt plot during eight growing seasons. The former plot was much better stocked at the start. The number of plants 5' and 10' and over in 1924 and in 1931 are given below :—

(In the report the letters E. and S. followed by Roman numerals refer to the project numbers of the research programme published on pages 63 to 65 and 73 of the Annual Report on Working Plans and Silviculture in Burma 1926-27. The letter E denotes "Experimental Plots" and the letter S "Statistical Plots".)

Height class.	FIRE PROTECTED PLOT.		BURNT PLOT.	
	1924.	1931.	1924.	1931.
5' and over . . .	706	810	211	501
10' and over . . .	9	757	10	384

It appears reasonable to suppose that clear felling over in regeneration will result in a reasonably full stock of saplings 10' and over in about 15 years.

Experimental Plot 7. Dipterocarpus tuberculatus.—Strip felling 1 chain, 2 chains and 3 chains wide, with and without fire protection.

The numbers of plants 5' and over per acre at the start were not very similar but making due allowance for this there appears to be no advantage in fire protection. The strip 1 chain wide has given poor results but there is little to choose between the 2 and 3 chain strips and these also differ little from the results of clear felling in experimental plot 6 mentioned above.

It is of interest to note the results of an accidental fire which took place in the hot weather of 1929. When a recount was made in the following January there was a decrease of only 35 plants in 600. The number of plants 5' high was reduced from 290 to 220 and the number 10' and over from 120 to 65. The result of the fire on the numbers of plants in these height classes was a set back of two years in the 5' and over class, three years in the 10' and over class.

E. I. b. c. and g. Dipterocarpus tuberculatus.—Experimental plot 8. Yinke Reserve, Katha Division. Seeding felling, burning and fire protection, with and without cleanings.

The fire protected plot was burnt in 1930 by accident, but the results judged by the number of saplings 5' and over in height are in favour of fire protection. The cleanings carried out in 1925 and 1929 have apparently produced slightly better growth. The growth in the plot which was neither cleaned nor protected from fire is very much poorer than in the others.

E. I. b. and c. Pentacme suavis.—Improvement fellings, with and without protection from fire.

So far as can be ascertained these plots have suffered from grazing, and since the floods of 1929, when cattle first entered the area, there has been a considerable reduction in the number of plants 5' and over in height. (There were 184 such plants in all plots in 1929 and there are now only 61.)

In the case of *D. tuberculatus* in the same plots, the numbers show a decrease of only one or two plants 5' and over in height, and this seems to

bear out the suggestion that grazing is the cause of the decrease as *in* is not eaten by cattle. *Shorea obtusa* suffered in the same way as *P. suavis*.

E. I. c.—Experimental plot 27 B, Compartment 13, Yinke Reserve.

D. tuberculatus.—This plot was burnt in April 1931 and the heights of 100 plants were measured before and after burning and gain at the end of December 1931 after the subsequent growing season.

Forty-one plants were burnt back to the ground, although the fire was reported to have been a mild one, and by the following December all but two of these plants had grown out of the 0'-6" class into higher classes. No plants 5' in height or over were burnt back. The control plot 27 A in compartment 19 was not burnt.

The plots were measured again on April 4th, 1932, after the fire had taken place in the burnt plot. The measurement showed that considerable growth had taken place during January to March and the number of plants over 5' had increased slightly in both plots, but the increase was greater in numbers in the protected plots while individual trees developed more rapidly in the burnt plot. The fire was again a mild one and no trees 5' or over were damaged (*cf.* plot 7 mentioned above in which saplings of over 10' were burnt back).

So far it would appear that fire protection results in establishing the crop more rapidly than burning. Unfortunately the fire protected plot was accidentally burnt and the fire was a fierce one and covered the whole of a fire protected compartment.

E. I. f.—The rate of growth of *Pentacme suavis* plants was measured in various experimental plots near Huokkyo, Shwegu Reserve, Bhamo Division.

It was found that the rate of growth of 22 whippy shoots and 12 plants, which had passed through this stage and had formed a stem, was most rapid during June (no figures are available for May). After the end of August to the end of October the rate of growth was small but it was continued up to the middle of December when measurements ceased. Plants which were injured and lost height were omitted and those whose height showed no alteration were included in the calculation.

The figures for the average growth during each month are as follows :—

Class.	HEIGHT GROWTH IN INCHES AND DECIMALS DURING						TOTAL.
	June.	July.	August.	September.	October.	November and December.	
Whippy shoots .	7.6	6.2	4.2	2.1	1.8	2.3	21.6
Saplings . . .	6.2	3.3	4.3	2.1	1.0	5.1	22.3

The figures given above do not bear out the statement made in Troup's "Silviculture of Indian Trees," page 55, that the growing period of *ingyin* is short and early. It is true that a few of the plants did not increase in height after July, but the majority certainly did so.

E. II.—Experimental Plot No. 11, Thaw Reserve, Shwabo Division. *Xylia dolabriformis* progress of regeneration after clear felling.

This plot is now covered with a dense mass of *Eupatorium odoratum* but the *Xylia* seems able to grow below it.

E. XVII. *Experiment 6 in the Hlaing Circle.*—The study of the survival of seedlings of *Xylia dolabriformis* shows that mortality is very heavy even with fire protection. In 6 plots in the Okkan and Bwet R serves, Insein and Promé Divisions, 11,000 seedlings were counted in January 1930 and in February 1932 only 4,000 or 36 per cent. were alive. The figures do not clearly show what the effect of weeding or of different density of overhead cover is, but on the whole weeding seems to be advantageous and the results are possibly better under light than under heavy cover.

Experiments 1 to 5, Pynmana Division, Yonbin Reserve.

These plots were laid out to study the best method of establishing regeneration of *Xylia dolabriformis* and *Tectona grandis* in an area which had been heavily worked, but heavy grazing and the trampling down of the young plants by buffaloes has impaired the results. So far as *Xylia dolabriformis* is concerned fire protection is apparently advantageous, as the percentage of survival is higher in the protected plot than in the burnt plot.

Experimental plots 7 and 8, Zigon Division (Kunsan), and Experimental plot 12, Namkum Reserve (Pinbaw), Myitkyina Division.

Experiments were carried out in connection with the Central Silviculturist's investigation into the question of the origin of teak seed and its effect on the success of *taungya* plantations in varying localities.

In the Zigon Division the percentage of germination was very bad in the case of all seed. Germination varied from nil (Tharrawaddy seed) to 4.9 per cent in nurseries, and from 1 to 21 per cent in the case of selected seed put out at stake in E. P. 8. Conditions appear to have been ideal for germination as rain and sun shine alternated during the whole of May and June

Experimental plot 7, Zigon Division, line planting, 100 plants each.

There were not enough plants from the Tharrawaddy seed to plant up a line. A certain mortality took place owing to defoliation as a neighbouring old plantation was attacked and the caterpillars were blown into the plot and ate the leaves of some of the transplants, but on Novem-

ber 1st, 1931, the percentage of success varied from 86 (Kanara and Zigon plants) to 96 (Travancore). Practically all the seedlings were 1' and over in height and the best growth was obtained from Myitkyina seed and the next best from Travancore seed which produced the largest plant of all, 5' 5" high.

Experimental plot 8, Zigon Division. Direct sowing at stake.

The seed was sown during the first half of May, three seeds each at 400 stakes. Germination was poor and on July 1st the percentage of success was 63 per cent. in the case of Zigon (local) seed, 57 per cent. Nilambur, 32 per cent. Myitkyina, 30 per cent. Kanara, 25 per cent. Travancore, 13 per cent. Khandesh and 3 per cent. Tharrawaddy.

The blanks were patched as far as seedlings were available and on the 1st November all plots showed a percentage of success of 96 or over on the number alive at stakes on July 1st. All the plants except two were 1' or more in height. The best growth was obtained from Myitkyina seed with Travancore seed very nearly equal.

Origin Seed.	NUMBER OF PLANTS.		HEIGHT CLASS ON 1-11-1931.						PERCENTAGE OF PLANTS.			
	On 1-7-31.	On 1-11-31.	Success per cent.	Under 6".	6" to 11".	1' 0" to 1' 5".	1' 6" to 1' 11".	2' 0" to 2' 5".	2' 6" to 2' 11".	3' 0" and over.	3' 6" and over.	3' 0" and over.
Nilambur .	400	301	08	..	..	280	4	86	..	15	20	4
Travancore	220	217	00	1	..	131	..	70	..	16	40	7
Zigon .	400	302	03	1	..	320	2	50	..	11	18	3
Kanara .	320	310	07	..	..	231	..	10	..	7	8	2
Myitkyina .	272	200	00	..	..	155	..	75	..	30	40	12

Unfortunately no record was kept to show whether the larger plants were from seedlings or from transplants or both.

Myitkyina Division—Experimental plot 12.

Seed from Khandesh, Travancore, Kanara and Tharrawaddy with local seed from Myitkyina were sown in nurseries. No record has been kept of the number of seeds sown.

Khandesh seed, collected in January 1931, and Tharrawaddy seed, collected at the end of April 1930, germinated very badly. It is possible that the date of collection may have influenced the quality of the seed. Conditions in Myitkyina were particularly favourable for germination during the year. In nurseries sown two and three years previously.

large numbers of seed germinated which had previously failed to do so. Late sowing (May 7th) of the Khandesh seed and the use of one year old seed from Tharrawaddy may also be contributory causes of the poor germination.

The best results were obtained from the Travancore seed and the next best from (local) Myitkyina seed, both of which were sown early on April 6th. The Tharrawaddy seed was sown on April 14th and that from Kanara on April 21st and this ought to have been early enough to give good results.

The percentage of survival was over 95 per cent. in all cases except in the case of seedlings from the Tharrawaddy seed.

E. XII.—Two adjacent teak sample plots, 8 and 9 in the Pynchaung Reserve, North Toungoo Division, plantation No. 25 of 1869, were re-measured during the year. The plots were formed in December 1922, and plot 9 has been left unthinned for comparison with plot 8 which has been thinned on the usual lines.

Unfortunately the re-measurement was not carried out until the end of February 1932 whereas the previous measurement in 1927 was made in November. This has probably made some difference to the diameters owing to the drying of the bark which takes place after the rains. This will not, however, affect the comparison between the thinned and unthinned plots.

There were 34 dominant trees in the unthinned plot and the average diameter increment during the last four years was 0.14" or 0.035" per annum, as against 0.31" and 0.085" per annum in the case of 32 trees in the thinned plot. During the previous 5 years, at the first re-measurement, the average annual increment of the unthinned plot, dominant trees was 0.125 and of the thinned plot 0.200. There has been a serious falling off in the rate of growth for which no reason is recorded, but the difference in time of measurement probably accounts for it, at least partially.

The area of the unthinned plot is $\frac{3}{4}$ of an acre and that of the thinned plot one acre. If the number of dominant stems in the unthinned plot is reduced to bring them to the same number per acre as in the thinned plot the average annual increment is still only just over half that of the trees in the thinned plot.

II—WORKING PLANS AND STATISTICS.

(i) *Yield Tables.*

Further figures are still being collected for volume tables for teak from various types of forest and we should now have enough to revise the existing tables.

The following new sample plots were formed during the year :—

S. IV. Volume increment per acre.	<i>Dipterocarpus tuberculatus</i>	.	3
Volume increment per acre.	<i>Pentace burmanica</i>	.	1
			<hr/>
	TOTAL	.	4

The series of sample plots is not yet complete.

The following plots were re-measured during the year :—

		Plots.
S. II. Volume increment per acre.	Teak	63
S. III. Volume increment per acre.	Other species	20
S. IV. Girth diameter increment	of individual trees other than	
teak . . . . .	. . . . .	30
TOTAL .		113

In Zigon and Tharrawaddy Divisions, owing to the rebellion, it was not possible to re-measure the following plots :—

[illegible]

S. II.—Figures for the rate of growth of teak plantations have been worked out and are given below :—

Age.	1st QUALITY.			2nd QUALITY.			3rd QUALITY.			REMARKS.
	Mean dia- meter in inches and decimals.	Mean height in feet.	No. of stems per acro.	Mean dia- meter in inches and decimals.	Mean height in feet.	No. of stems per acro.	Mean dia- meter in inches and decimals.	Mean height in feet.	No. of stems per acro.	
10 years	5.5	58	275	4.4	47	360	2.7	32	750	The number of sample plots for 3rd quality teak being few the figures may not be correct.
20 "	8.5	80	165	6.9	65	200	5.1	51	360	
30 "	11.0	92	100	9.0	77	133	7.0	65	220	
40 "	13.3	103	75	11.1	87	88	8.7	73	140	
50 "	15.7	112	60	13.1	95	70	..	..	..
60 "	18.0	120	50	15.1	101	60	..	..	..
70 "	20.3	127	40	16.9	106	35	..	..	..
80 "	..	..	..	18.7	110	53	..	..	..
90 "	..	..	..	20.3	112	55	..	..	..

NOTE.—The figures—Mean diameter, Mean height and the number of stems per acre—were collected immediately after the plots were thinned.

As compared with the diameter of the trees in the Nilambur plantations, Madras, those of Burma are approximately 10 years' growth in advance.

S. III.—In sample plot No. 53, Tharrawaddy Division, *Xylia dolabriformis* of 1924 was measured first in November 1929 and again in January 1932. The diameter increment was as follows:—

Species.	No. of trees.	Diameter class.	Total diameter increment in 2 years in inches.	Average annual diameter increment in inches.
<i>Xylia dolabriformis</i>	61	1"	30.75	0.25
	191	2"	166.05	0.43
	130	3"	143.65	0.55
	21	4"	31.95	0.76
	1	5"	0.55	0.27
TOTAL	404	..	373.55	0.46

In sample plot No. 35, *Xylia dolabriformis* has grown up as the result of 'Y' fellings of 1918 and now varies from 2" to 11" in diameter. The rate of diameter increment is as follows for the last 5 years:—

Diameter class.	No. of trees.	Average annual diameter increment. Inches.
1" to 2"	5	0.046
2" to 3"	22	0.103
3" to 4"	29	0.162
4" to 5"	21	0.202
5" to 6"	15	0.238
6" to 7"	21	0.248
7" to 8"	16	0.259
8" to 9"	11	0.314
9" to 10"	7	0.361
10" to 11"	4	0.270
11" to 12"	1	0.270
TOTAL	152	0.209

S. IV and E. XVI.—In February 1927 the whole of compartment 43, Mokka Reserve, Tharrawaddy Division, was formed into a sample plot to study the diameter increment of *Tectona grandis* and *Xylia dolabriformis* with and without improvement fellings. The forest is classed as moist upper mixed deciduous with small parts of a drier type. All trees which were not in a dominant condition were numbered and measured and their position on the ground was classified as (1) Ridge top, (2) Slopes and (3) Flat ground at the bottom of the slopes. Individual trees of fairly similar diameter, classed as suppressed or dominated, and in similar positions were then selected, some being freed from overhead or side cover and others being left unassisted.

A total of 316 teak trees varying from 8" to 28" in diameter were measured, 168 of which were freed from neighbouring trees, 158 being left untended. The result shows that in all 4" diameter classes except one, the improvement fellings caused an increase of diameter. The exceptional case was a comparison between two trees and one tree and is of little importance. Taking all the trees measured the average annual diameter increment was 0.140" for the untended trees and 0.215" for the trees freed of cover, a difference of 0.075.

The results with *Xylia dolabriformis* are similar though, as was to be expected in the case of a shade bearer, the difference is less marked. The increment was 0.151" per annum for 68 untended trees as against 0.192" for 77 trees freed of cover, or 0.041" per annum in favour of improvement fellings.

The diameter increments of 943 teak trees in this compartment (including those mentioned above) have also been worked out for the 5-year period. The figures by 4" diameter classes are as follows:—

Diameter class.	No. of trees.	Total increment in 5 years. Inches.	Average annual diameter increment. Inches.
8" to 12"	30	20.50	0.137
13" to 16"	172	145.55	0.169
17" to 20"	314	262.45	0.167
21" to 24"	261	213.15	0.163
25" to 28"	125	94.30	0.151
29" to 32"	42	31.15	0.148
33" and 34"	4	0.95	0.048
TOTAL	948	768.05	0.162

Similar figures for 622 *Xylia dolabriformis* trees are as follows:—

Diameter class.	No. of trees.	Total increment in 5 years. Inches.	Average annual diameter increment. Inches.
8" to 12"	14	10.40	0.149
13" to 16"	89	68.05	0.154
17" to 20"	157	122.35	0.156
21" to 24"	186	138.75	0.149
25" to 28"	131	70.35	0.117
29" to 32"	43	25.65	0.119
36"	2	0.75	0.075
TOTAL	622	442.90	0.142

S. IV.—Diameter increment of *Pentacme suavis (ingyin)* trees in sample plot 14, Bilumyo Reserve, Myitkyina Division, for a period of 5 years from 2nd April 1927 to 19th November 1931:—

Diameter class (Inches).	No. of trees.	AVERAGE OF DIAMETER.		Total diameter increment in 5 years.	ANNUAL DIAMETER INCREMENT.			REMARKS.
		2nd April 1927.	10th Novr. 1931.		Maximum (Inches and decimals).	Minimum (Inches and decimals).	Average (Inches and decimals).	
4"—7"	3	7.33	7.48	.45	.02	.01	.030	
8"—11"	46	10.07	11.01	15.45	.16	..	.067	3 trees did not put on any increment.
12"—15"	57	13.58	13.91	18.60	.16	..	.066	3 Do.
16"—19"	17	17.65	18.11	7.80	.22	..	.062	1 Do.
20"—23"	1	20.05	20.25	.20	.04	.04	.010	
4"—23"	124	12.10	13.30	42.50	.22	0.1	.068	

Diameter increment of in (*Dipterocarpus tuberculatus*) trees in sample plots 1 to 5, Yinke Reserve, Katha Division, for a period of 9 years from March 1923 to February 1932:—

Diameter class (Inches).	No. of trees.	AVERAGE DIAMETER.		Total increment in 9 years.	ANNUAL DIAMETER INCREMENT.			REMARKS.
		March 1923.	February 1932.		Maximum (Inches and decimals).	Minimum (Inches and decimals).	Average (Inches and decimals).	
8"—11"	8	11.23	11.85	4.05	.105	.022	.069	
12"—15"	100	14.35	15.12	77.00	.211	.055	.080	
16"—19"	172	17.00	18.83	152.75	.222	.017	.060	
20"—23"	105	21.04	22.45	84.85	.244	.011	.030	
24"—27"	59	25.53	26.37	40.50	.180	.011	.003	
28"—31"	16	30.15	30.68	8.50	.240	.035	.059	
8"—31"	460	19.30	20.13	377.56	.241	.011	.091	

Sample plots 24 to 30 and 35 to 37, Insein Division. The average annual girth increment of various species suitable for match making, growing in different types of forest in the Insein Division, are shown below :—

Species.	LOWER MIXED DECIDUOUS FOREST TYPE.		MOIST UPPER MIXED DECIDUOUS TYPE.		EVERGREEN FOREST TYPE.	
	No. of trees.	Average annual girth increment over a period of 5 years (Inches and decimals).	No. of trees	Average annual girth increment over a period of 5 years (Inches and decimals).	No. of trees	Average annual girth increment over a period of 5 years (Inches and decimals).
1	2	3	4	5	6	7
<i>Bombax insigne</i> . .	16	0 56	34	0 14	..	..
<i>Sterculia alata</i> . .	..	..	1	0 63	10	0 32
<i>Sterculia campanulata</i> .	20	0 74	14	0 30	93	0 46
<i>Ocina woder</i> . .	4	0 35	14	0 28	..	..
<i>Spondias mangifera</i> .	10	0 35	80	0 40	5	0 73
<i>Albizia stipulata</i> .	..	..	..	..	3	3 37
<i>Duabanga sonneratioides</i>	..	..	..	..	1	1 28
<i>Tetrameles nudiflora</i> .	..	..	1	1 66	..	..
<i>Sarcocephalus cordatus</i> .	11	0 46	7	1 46	1	0 74
<i>Anthocephalus cadamba</i>	6	0 4	..	..	..	..
<i>Hymenodictyon excelsum</i>	..	..	3	0 47	..	..
<i>Stereospermum ohelonoides</i>	..	..	9	0 06	..	..

S. IV.—Sample plot 33, Kaing Reserve, Pyinmana Division. Semi-evergreen forest.

The diameter increments of the three species known as *ma-u* over a period of 4 years are shown below :—

Species.	Diameter classes in 1927.	No. of trees.	Average annual diameter increment.
<i>Anthocephalus cadamba</i> (<i>ma-u-let-tanshe</i>).	4" to 11" .	33	0 31"
<i>Sarcocephalus cordatus</i> (<i>ma-u-ladon</i>)	4" to 8" .	5	0 58"
<i>Duabanga sonneratioides</i> (<i>ma-u-let-tanshe</i> or <i>myaulngo</i>).	4" to 12" .	10	0 48"

S. IV.—Sample plots 22 and 23 in Magayi and South Hlaing Yoma Reserves, Insein Division. The plots were formed in November 1921

and remeasured in November 1926 and in January 1932. The increment worked out as follows :—

Species.	No. of trees.	ANNUAL GIRTH INCREMENT OVER A PERIOD OF 5 YEARS.			ANNUAL GIRTH INCREMENT OVER A PERIOD OF 10 YEARS.		
		Maximum (Inches and decimals).	Minimum (Inches and decimals).	Average (Inches and decimals).	Maximum (Inches and decimals).	Minimum (Inches and decimals).	Average (Inches and decimals).
<i>Dillenia pentagyna</i> .	12	·68	·64	·27	·56	·61	·31
<i>Garcinia cora</i> .	2	1·36	·56	·96	1·11	·56	·84
<i>Dipterocarpus tuberculatus</i> .	8	·90	·36	·66	·77	·31	·54
<i>Dipterocarpus alatus</i>	11	1·59	·44	1·06	1·67	·27	1·09
<i>Shorea obtusa</i> . .	1	..	..	·22	..	..	·31
<i>Garuga pinnata</i> .	4	·92	·14	·49	·82	·19	·49
<i>Schleichera trijuga</i> .	7	1·30	·20	·07	1·41	·17	·62
<i>Mangifera indica</i> .	12	1·60	·40	1·04	1·65	·45	·99
<i>Odina wodier</i> . .	20	1·10	·03	·49	·67	·01	·36
<i>Dalbergia eultrata</i> .	6	1·00	·06	·59	1·04	·31	·65
<i>Xylia dolabriformis</i> .	10	1·70	·02	·89	1·40	·10	·80
<i>Carallia lucida</i> .	5	1·24	·59	·97	1·10	·52	·77
<i>Terminalia belerica</i> .	16	1·06	·10	·61	1·37	·14	·56
<i>Terminalia chebula</i> .	6	1·32	·16	·64	1·03	·16	·50
<i>Terminalia pyrifolia</i> .	7	1·26	·19	·78	1·54	·25	·77
<i>Terminalia tomentosa</i>	5	·46	·20	·24	·31	·15	·22
<i>Anogeissus acuminata</i>	17	1·54	·58	1·11	1·62	·65	1·06
<i>Eugenia</i> spp. . .	3	1·46	·74	1·12	1·23	·59	·95
<i>Carya arborea</i> .	6	·86	·64	·35	·68	·65	·20
<i>Lagerstroemia flos reginae</i> .	12	1·94	·46	·96	1·56	·52	·93
<i>Lagerstroemia tomentosa</i> .	1	..	..	·76	..	..	·51
<i>Homalium tomentosa</i>	14	1·02	·19	·49	·74	·22	·40
<i>Anthocephalus cadamba</i> .	11	2·72	·20	·86	1·66	·19	·64
<i>Adina cordifolia</i> .	12	·90	·18	·53	·71	·07	·41
<i>Stephanye discolorifolia</i> .	15	1·16	·04	·37	·62	·05	·37
<i>Nauclea sessilifolia</i> .	2	·56	·26	·39	·46	·28	·37
<i>Hymenodictyon excelsum</i> .	1	..	..	·40	..	..	·32
<i>Dysoxylum binectarifolium</i> .	5	1·06	·28	·56	·62	·16	·50
<i>Stereospermum neuranthum</i> .	6	·94	·36	·54	·82	·31	·57
<i>Omelina arborea</i> .	1	..	..	1·14	..	..	·89

S. IV.—Sample plots 32 and 33, Compartment 30, South Hlaing Yoma Reserve, Insein Division. Diameter increments of coppice of various species in thinned and unthinned plots.

Large numbers of the marked trees have been illicitly felled and the effect of the thinning cannot now be judged but generally the increment is greater in the thinned plot.

The average annual diameter increments over a period of 5 years are as follows :—

Species.	No. of trees.	Diameter classes.	Average annual diameter increment. Inches.
<i>Pterospermum semisagittatum</i>	64	6"	0.18
<i>Xylia dolabriformis</i>	34	5"	0.27
<i>Homalium tomentosum</i>	40	5"	0.40
<i>Phyllanthus emblica</i>	11	4"	0.04

S. V.—Shrinkage figures for girth of 130 teak trees at b.h. over bark (a) two months after girdling, (b) one year after girdling, and at 4' 10" under bark one year after girdling in Prome plantation of 1858 :—

Girth class.	No. of trees.	AVERAGE GIRTH SHRINKAGE OVER BARK.		Average girth shrinkage under bark one year after girdling.	REMARKS.
		2 months after girdling.	One year after girdling.		
3'—3' 6"	21	0.56"	0.03"	0.13"	The maximum shrinkage 2 months after girdling was 1.30"; one year after 2' 6".
3' 6"—4'	21	0.61"	1.00"	0.13"	
4'—4' 6"	22	0.56"	1.03"	0.17"	
4' 6"—5'	22	0.80"	1.20"	0.13"	
5'—5' 6"	10	0.70"	1.24"	0.18"	
5' 6"—6'	16	0.77"	1.24"	0.16"	
6'—6' 6"	10	0.70"	1.28"	0.25"	

The average bark thickness of these trees is unusually small being only 0.45". The plantation is situated on a steep hill side facing west and the soil is comparatively poor. Trees standing on the top of the ridge hardly shrank at all.

S. V.—Rough average figures for age/height and age/diameter of *Gmelina arborea* (yemane) from 8 sample plots in plantations in the Northern Shan States, Myitkyina, Katha, Tharrawaddy and Ataran Divisions, have been worked out.

The age/height curve was obtained from the heights of the tallest trees. The age/diameter curve was obtained from the average diameter of the main crops.

Plots which have been measured twice have been used twice (*e.g.* at the age of five and again at the age of ten) :—

Age (years).								Height (feet).	Diameter (inches).
3	.	.	.	.	.	.	.	29	2.3
4	.	.	.	.	.	.	.	35	3.1
5	.	.	.	.	.	.	.	41	3.9
6	.	.	.	.	.	.	.	46	4.7
7	.	.	.	.	.	.	.	50	5.4
8	.	.	.	.	.	.	.	54	6.0
9	.	.	.	.	.	.	.	57	6.5
10	.	.	.	.	.	.	.	59	7.0
11	.	.	.	.	.	.	.	61	7.4
12	.	.	.	.	.	.	.	62	7.7

The heights are very similar to those of teak Class I in the Nilambur tables. The diameters are rather greater than those of Class I teak.

(ii) *Preparation and control of regular Working Plans.*

(a) PREPARATION AND REVISION.

Field Work and Area.

Owing to financial stringency, all working plans field work was temporarily closed down during the year. This is unfortunate as it entails arrears in the preparation of working plans and also the disbanding of the working plans labour which has been highly trained during the past several years. In this connection Mr. H. R. Blanford, O.B.E., Conservator of Forests, Sittang-Tenasserim Circle, in his Circle Annual Report for the year writes—

“The temporary closing down of all working plans field work is most unfortunate. Not only does it lead to considerable arrears of work which must be tackled urgently when work can start again, but it also leads to the disbandment of the working plans labour necessitating considerable training with less satisfactory work when the parties are reconstituted. In this Circle, field work on revision is urgent or will shortly be so in South Youngoo, North Pegu, South Pegu and Thauingyin Divisions, while no field work has been done in Shwegyin, Thaton and Salween, where at any rate some idea of the stocking and distribution of the teak stock is necessary. The same remarks apply to several other Circles and it is to be hoped that field work on working plans will be restarted at the earliest possible date.”

Compilation.

During the year under report new plans for an area of 2,030 square miles and revised plans for 1,555 square miles were sanctioned as against new plans for 1,472 square miles and revised plans for 420 square miles in the preceding year.

The position as regards working plans at the close of the year under report as compared with that at the close of 1920-21, when the Working Plans Circle was formed, is shown below. For the purposes of comparison the figures for the Federated Shan States are included—

	1920-21.	1931-32.
	Sq. miles.	Sq. miles.
Area under sanctioned plans	10,855	23,348
Area for which plans are under preparation	328	2,504
Area for which plans are required	8,236	1,525
TOTAL	19,419	27,377

From the above it will be seen that the area brought under sanctioned plans during the period 1920-21 to 1931-32 was 12,493 square miles, an average of 1,081 square miles per year. It must, however, be understood that this area includes certain areas under "paper" plans pending enumeration by a working plans party, and the whole of the area shown as under sanctioned plans or for which plans are under preparation has not been fully prospected by parties in the field.

The following shows approximately the work done or in hand at the close of the year since the formation of the Working Plans Circle in 1920-21 :—

*Plans based mainly on field work.**

Original	8,523
Revision	5,814
<i>" Paper " Plans—</i>	
Original	6,781
Revision	2,862
TOTAL	23,080

* Even this includes areas for which detailed enumeration is unnecessary and was not carried out.

The following shows the areas of reserved forests for which working plans are under compilation and the progress made during the year :—

(a) By Special Working Plans Officers.

<i>Zigon Forest Division—</i>	Sq. miles.
Revision of existing plans	461

As stated in last year's report field work had to be stopped on account of the rebellion. The current plan expires in 1932-33. It is not known when it will be possible to resume work on the revision.

	Sq. miles.
<i>Prome Forest Division—</i>	
Revision of existing plans	516

The original draft plan prepared by Mr. J. S. Vorley, Deputy Conservator of Forests, was revised by him during the rains of 1931.

	Sq. miles.
<i>Thayemyo Forest Division—</i>	
Revision of existing plans	1,007

The plan has been approved by the Chief Conservator of Forests after the close of the year and sent to the press for proof.

	Sq. miles.
<i>North Toungoo Forest Division—</i>	
Revision of existing plans	504

The plan was sanctioned during the year with retrospective effect from 1929-30.

	Sq. miles.
<i>South Toungoo Forest Division—</i>	
Revision of existing plans	853

The field work, started last year, could not be continued during the year owing to financial stringency and unsettled conditions.

	Sq. miles.
<i>Mu Forest Division—</i>	
Preparation of original plans	604

This plan was sanctioned during the year with retrospective effect from 1929-30.

	Sq. miles.
<i>Maymyo Forest Division—</i>	
Revision of existing plans	317
Preparation of original plans	778
TOTAL .	<u>1,095</u>

The plan was sanctioned during the year with retrospective effect from 1929-30.

	Sq. miles.
<i>Yamethin Forest Division—</i>	
Revision of existing plans	771

The plan has been approved by the Chief Conservator of Forests and is now in the press.

The total area under examination during the year was :—

Revision	Sq. miles.
Original	2,591
	<hr/> 1,007
TOTAL	<hr/> 3,598

The following plans were sanctioned during the year under report :—

	Sq. miles.
(i) Working Plan for the North Toungoo Forest Division—Revision	504
(ii) Working Plan for the Mu Forest Division—Original	664
(iii) Working Plan for the Maymyo Forest Division—	
Revision	317
Original	778
	<hr/> 1,096
TOTAL	<hr/> 2,263

All these plans took effect from 1929-30.

(b) *By Officers other than Special Working Plans Officers.*

The following “paper” working plans were either sanctioned or were in hand during the year :—

	Sq. miles.
<i>Tharrawaddy Forest Division—</i>	
Revision	337
Original	0
	<hr/> 346
TOTAL	<hr/> 346

The plan was sanctioned during the year with retrospective effect from 1928-29.

	Sq. miles.
<i>Arakan Forest Division—</i>	
Original	531

The plan for the old South Arakan Division written by Mr. W. C. Rooke, Deputy Conservator of Forests, was reported to have been received in the office of the Conservator of Forests, Hlaing-Delta Circle, just before the close of the year.

	Sq. miles.
<i>Shwegyin Forest Division—</i>	
Revision	306

The existing plan expired at the end of 1931-32 and a new plan for the period 1932-33 to 1941-42 is under preparation.

	Sq. miles.
<i>Tavoy Forest Division—</i>	
Original	82

Part I, excepting paragraphs on past yield and expenditure, was reported to have been compiled during the year. Now that the two Divisions—Tavoy and Mergui—have been amalgamated, Part I for Mergui partly written up by Mr. F. W. Withers will probably be combined with Part I of Tavoy.

	Sq. miles.
<i>Myittha Forest Division—</i>	
Revision	43
Original	722
TOTAL .	765

The plan was approved by the Chief Conservator of Forests after the close of the year.

	Sq. miles.
<i>Kaukkue Forest Division—</i>	
Revision	224
Original	162
TOTAL .	386

This plan drawn up by the Divisional Forest Officer is being dealt with in the Working Plans Office.

	Sq. miles.
<i>Mciktila Forest Division—</i>	
Revision	163
Original	471
TOTAL .	634

The plan was sanctioned during the year with retrospective effect from 1929-30.

	Sq. miles.
<i>Northern Shan States Division—</i>	
Revision	244
Original	108
TOTAL .	352

The plan was sanctioned during the year with retrospective effect from 1929-30.

Upper Chindwin Forest Division.

It is reported that the preparation of the working plan for the Wega-tha Fuel Reserve mentioned in last year's report was suspended after completion of Part II, as Messrs. The Indo-Burma Petroleum Company is not likely to require wood fuel in the near future owing to trade depression.

Part I (past history) of divisional working plans being considered necessary for the following Divisions the consent of the Local Government is being obtained for their preparation:—

Forest Circle.	Forest Division.
Chindwin	{ Lower Chindwin. Myitha. Yaw.
Sittang-Tenasserim	{ North Pegu. Thaon-Salween. Thaunggyin. Tavoy-Mergui.
Hlaing-Delta	{ North Arakan.

The following working plans have already lapsed or will lapse within the next three years:—

Circle.	Division.	Working Circle.	Area in sq. miles.	Year of lapse.	REMARKS.	
1	2	3	4	5	6	
Hlaing-Delta	Tharrawaddy	Hills . . .	340	1927-28	Incorporated in divisional plan sanctioned dur- ing the year.	
		Plains . . .		1931-32		
	Prome . .	Divisional plan	510	1931-35	Under revision.	
	Zigon . .	Do.	451	1932-33	Do.	
	Delta . .	Do.	1,109	1933-34		
Sittang-Tenasserim.	N. Toungoo	Do.	501	1929-30	Revised plan which takes effect from 1929-30 was sanc- tioned during the year.	
	S. Toungoo	Do	553	1932-33	Under revision.	
	Shweglio	Do.	300	1931-32	Do.	
	North Pegu	Do.	576	1932-33	Gridding period ex- pires in 1935-36.	
	Thaon . .	Do.	529	1934-35		
	Salween . .	Do.				
	Ataran . .	Do.	1,000	1934-35		
Northern	Myithyia	Moheyin Circle.	Working	43	1929-30	Incorporated to divisional work- ing plan under preparation.
Chindwin	U. Chindwin	Mawku Circle.	Working	309	1930-31	Gridding extended to 1936-37.

Circle.	Division.	Working Circle.	Area in sq. miles.	Year of Japae.	REMARKS.
1	2	3	4	5	6
Old Central	U. Chlodwin	Ahlaw Working Circle.	188	1933-34	Girdling extended to 1939-40.
	Myittha	Kale Working Circle.	223	1925-29	} Girdling extended to 1936-39.
	Do.	Nwa Working Circle	184	1931-32	
	Maymyo	Madaya W. O.	317	1920-27	} Incorporated in divisional plans sanctioned dur- ing the year.
	Melkilla	Platna W. O.	153	1920-30	
Fed. Shan States	Yamethin	Divisional plan	771	1920-30	Revised plan in press.
	Mongmit	Namme W. O.	377	1925-29	} Girdling extended to 1939-37. The preparation of a divisional plan is under con- sideration.
	Do.	Nanhan, Nampaw and Subok Res.	248	1934-35	

NOTE.—When divisional working plans are mentioned only areas of reserved forests are entered.

Owing to the uncertainty as to when funds will be available, the tentative programme of working plans field work for the next five years cannot be drawn up at present.

(b) ADDITIONS TO, AND MODIFICATIONS OF, SANCTIONED WORKING PLANS.

The following are interesting additions to, and modifications of, sanctioned working plans.

South Pegu Division.—A revised improvement felling scheme for the period from 1931-32 to 1933-34, a scheme to work hardwoods under a five-year lease, and a cleaning and thinning scheme for plantations for the period from 1932-33 to 1941-42 were sanctioned during the year. The scheme to work matchwood species in certain reserves was approved by the Chief Conservator of Forests.

Salween Division.—The girth limit for teak was raised from 7' to 7' 6" in moist forest and fixed at 6' 6" in dry forest.

Yaw Division.—The girth limit for teak fixed at 7' 6" in all types of forest by the working plan for the North and South Gangaw Working Circles was reduced to 6' 6" for dry forest to conform with the prescriptions of other working plans in force in the Division.

CENTRAL PROVINCES AND BERAR.

I.—SILVICULTURE

A. GENERAL.

(i) *Seed Year.*

The seeding of all forest species was very satisfactory owing to a good monsoon. The heavy rains and hail storms, however, damaged the flowering of many species particularly in Betul and Akola Divisions. High winds in March 1932 are reported to have affected the crop of *mahua* (*Bassia latifolia*) and *achar* (*Buchanania latifolia*) in Betul Division.

(ii) *Tectona grandis.*(a) *Natural Regeneration.*

Seeding regeneration.—The reports from various divisions show that the regeneration from teak seed has been very satisfactory owing to heavy rains. The burning operations in Allapilli and Pedigundam Ranges (South Chanda) are reported to have resulted in vigorous response. Many long suppressed seedlings were killed back and the subsequent reproduction is very promising.

In North Chanda it seems unlikely that the fellings in P. B. I areas have been responsible for any great increase in the natural regeneration of teak. The Improvement Fellings carried out during the last 10 years have probably contributed steadily but surely to the regeneration of teak in many areas, particularly of Mul Range.

Reports from Melghat and Jubbulpore record excellent teak regeneration wherever the overhead canopy was sufficiently dense to restrain grass and weed growth. Jubbulpore reports very poor seedling reproduction in coupes under regeneration fellings.

In Betul it is held that light is not a factor which induces teak regeneration in a forest, but rather a dense overhead canopy in the first instance, the absence of grass, and the presence of a good soil. When the teak regeneration has appeared on the areas, the steps to be taken to improve it are firstly cutting back operations of the young and crooked shoots, followed by a very heavy opening of the overhead canopy.

In Hoshangabad the experience of the four years that elapsed since the introduction of the new Working Plan has shown that the annual P. B. I coupes in the Teak High Forest Felling Series are usually sufficiently well stocked as a result of clear felling, though teak coppice forms a considerable proportion of the new crop. Successive regeneration fellings are now therefore seldom resorted to and the annual coupes

were usually more or less clear felled. The results may on the whole be considered very satisfactory. It is very noticeable that seedling regeneration of teak is usually best in bamboo areas, where the shade of bamboo restricts the growth of grass.

One very striking result of clear fellings, both in high forest and in coppice (low forest) coupes, has been the abnormal encouragement which such a treatment gives to the light demanding trees. More than one area has been seen which, prior to the clear fellings, was mixed forest with scattered teak in the over-wood, covering fairly abundant teak regeneration and advance growth. In consequence of the clear fellings and cutting back of the teak, the teak has shot up to a height of 15 to 25 feet in two or three years, while the coppice of the mixed species is of little more than half this height. The operation is likely thus to succeed in converting mixed forest to an almost pure teak overwood with an under storey of inferior species. If a sufficient proportion of trees of miscellaneous species are to be maintained, which is now usually considered a silvicultural necessity, it may eventually be necessary to modify the present systems to a form of coppice with standards.

Coppice reproduction has been on the whole excellent in all the divisions. In North Chanda, a reduction in the rate of height growth after two or three years is observed, while in Betul teak coppice in clear felled areas has experienced a great set back from accidental annual fires.

(b) *Artificial Regeneration.*

Buldana and Nimar Divisions report that the teak seed sown in 1930 germinated well during 1931 rains. Yeotmal, however, reports poor success with teak in almost all cases of sowings made in Kinwat Range inspite of using weathered seed.

The Divisional Forest Officer, South Chanda, reports that five acres in compartment No. 28-A Plains Felling Series of Allapilli Range were sown with weathered teak seed and the results are satisfactory. All *nala* areas in the regeneration areas are being sown with teak seed. In the Bhimaram hills contour trenches are being dug in all worked coupes to hold up teak seed. The old *taungya* plots in Allapilli and Sironeha Ranges having served their purpose will be abandoned.

The work of artificial regeneration of teak in Bilaspur (old North Raipur) Division was organised exceedingly well. The work carried out by Deputy Ranger Tara Singh, the plantation ranger, is the largest of recent years in the province, covering over 20 acres and it has proved most successful. Teak seed is sown in a special nursery in April and watered; the seedlings are pricked out in the *donas* (cups of leaves)

which are kept under shade till the break of rains when they are 4"—8" high. They are then planted out in the prepared pits without disturbing the root system.

(iii) *Shorea robusta*.

Satisfactory *sal* regeneration is reported from Balaghat and Jubbulpore Divisions. It is interesting to follow the progress of the naturally regenerated young *sal* crops in the South Raipur Division to which allusion was made in last year's report. Fires occurred in April 1931 in several compartments severely damaging seedlings and coppice growth, and is estimated to have caused the loss of 5—6 years' growth. It seems absolutely necessary rigidly to protect all compartments in which regeneration fellings have been carried out so as to prevent the occurrence of fire until such time as rough bark has been formed for at least 6 feet on the stems of the young crop: this will probably not be until 15—20 years after the fellings.

(iv) *Other species*.

Saj (*Terminalia tomentosa*).—In Hoshangabad, *saj* appears to be the worst sufferer in coppice coupes. Some modification in the treatment is desirable to preserve this important and in places valuable associate. The growth of *saj* coppice in Katni Felling Series (Jubbulpore), is, however, reported to be exceptional where shoots of 3 years are mostly 9 to 10 feet high.

Tinsa (*Ougeinia dalbergioides*).—In most places in Jubbulpore Division where *tinsa* occurs regeneration from seed is reported to be prolific, but the seedlings never seem to grow up.

Anjan (*Hardwickia binata*).—Natural regeneration is on the whole fair throughout Buldana Division. *Anjan* was sown broadcast in 1928-29 in C/15 of Borkher Felling Series (Buldana): 1000 seedlings representing about 10% of the original stock were reported to be alive at the close of the year: the average and maximum heights being 9" and 17" respectively.

Babul (*Acacia arabica*).—Natural regeneration was on the whole satisfactory in Buldana *babul* areas.

Chir (*Pinus longifolia*).—Out of 1717 seedlings of *chir* transplanted in the new and old nurseries at Chikalda only 70 plants survived by the end of March 1932.

Baranga (*Kydia calycina*).—Has regenerated profusely in recent years in Deori and Rehli Ranges (Saugor) where it has now formed a valuable

lower storey under the teak thereby greatly assisting regeneration of the latter species.

Miscellaneous species.—In Chhindwara, with the exception of *saj* (*Terminalia tomentosa*) and *bija* (*Pterocarpus marsupium*) which do not reproduce themselves freely from seed, the natural regeneration of other species is excellent generally speaking throughout the Division. There is to be found almost everywhere in the division a switchy form of *dhaura* (*Anogeissus latifolia*) ranging in height from 2' to 4' and several years old; it never seems to grow up. Similar stunted growth of *saj* and *tendu* is fairly common in certain localities.

The following measurements of miscellaneous coppice growth in clear-felled coupes of Murwara, Sihora and Jubbulpore Ranges (Jubbulpore) are of interest :—

Species.	Average height (feet).	
	In 2 years.	In 3 years.
<i>Lagerstræmia parviflora</i>	7—8	9—10
<i>Grewia</i> spp.	7—8	12—15
<i>Kydia calycina</i>	9—10	12—15
<i>Grewia tiliaefolia</i>	8—12	12—15
<i>Boswellia serrata</i>	5—6	8—9
<i>Acacia catechu</i>	4—5	6—7
<i>Diospyrus melanoxylon</i>	5—6	8—9
<i>Terminalia tomentosa</i>	4—5	7—8
		(0—10 in Katni Felling Series).

Satisfactory regeneration of the species *babul*, *bija*, *neem*, *semal*, *siris*, *siwan*, *shisham* and *tinsa* sown in the agri-silvicultural plantations is reported from the Berar Division.

(v) Bamboo (*Dendrocalamus strictus*).

(a) Natural Regeneration.

In Mandla Range (Jubbulpore) the regeneration is reported to be particularly good in closed and fire protected coupes and very dense in hilly areas where the old bamboo seeded sporadically. Even in Jubbulpore Range where grazing is very heavy bamboo regeneration is said to be thick in many places. In some areas monkeys have caused much damage to the young culms.

In the recently felled coupes of Korai, Ganginala and Seoni Ranges (Seoni Division) where bamboos were clear-felled the growth of new culms is said to be excellent. It is expected in Hoshangabad Division

that clear-felled bamboo in the annual timber coupes will recover completely in 8 years, *i.e.* in two bamboo rotations.

In Chhindwara bamboos were clear-felled in coupes I and II of various High Forest and Coppice with Standards felling series some 3—1 years back and every clump is now reported to be well on its way to recovery. The first year's growth is distinctly poor, but there is a decided improvement in the second year and complete recovery ensues in the third year.

(b) *Artificial Regeneration.*

In Amraoti Division nursery raised bamboo seedlings about 9" high were planted out along Deonadi in pits $1' \times 1' \times 1'$ at a cost of Rs. 7-14; about 75% plants survived and were doing well by the end of March 1932.

In coupes Nos. 27 and 4, Umerda Block, Yeotmal Division, 4943 bamboo transplants from nursery were planted out in $1\frac{1}{2}' \times 1\frac{1}{2}' \times 1\frac{1}{2}'$ pits; of these 25% were damaged by pigs and rats and the remaining 75% are reported to be flourishing.

The bamboo propagation work in Akola Division was continued.

(vi) *Agri-silviculture.*

The work under this head is assuming a special importance in various divisions of the province. The Berar (Western Circle) Divisions carried out this work as usual and the efforts were extended to Nimar Division also. South Mandla reports a complete success over a 5-acre plot in Motinala Range.

(vii) *Thinnings.*

Beneficial results of past thinnings are reported from Hoshangabad, Chhindwara and Nagpur-Wardha Divisions: it is stated that regeneration abounds in certain areas thinned in the past in Nagpur-Wardha Division.

Jubbulpore, Nimar, Nagpur-Wardha report that the canopy has nearly closed in or in certain cases has entirely closed up in about 3-4 years' time as though it had never been touched. In Nimar the peculiar tendency of teak to close up soon after thinnings is markedly noticeable and calls for much heavier thinnings than has been customary.

In Hoshangabad it is recorded that the great danger of thinnings in teak forests appears to be that they are likely to unduly encourage the teak which in many areas is already in excessively high proportion. For this reason it is held that the practice of girdling trees of mixed

species in teak areas should be strictly prohibited, as this is likely to encourage the process of their extermination which is further hastened by the process of clear fellings in the main coupes which greatly favours the teak.

(viii) *Cleanings and cutting back operations.*

In several divisions cultural operations had a set back owing to the economic depression. Hoshangabad and Balaghat report that coupes are completely felled by the contractors who have now learnt the simple rules for fellings: this obviates the necessity of cultural operations.

B. EXPERIMENTAL AND STATISTICAL.

(i) *Local.*

The Divisional Forest Officers maintained 8 local experimental plots, 4 of teak natural reproduction and development (South Chanda, old North Raipur and Saugor), 1 of miscellaneous species (old North Mandla), 2 of *anjana* (*Hardwickia binata*) coppice reproduction (Nimar) and 3 of erosion (Balaghat), and their records were scrutinised at times and kept up to date, as far as possible, by the Silviculturist.

Teak.—The advance growth of teak poles up to 30" girth retained in coupe No. 2, Maharaji (old North Raipur) to form the future crop is reported to be making no recovery or progress. Its retention appears to be unnecessary.

Pterocarpus marsupium.—As regards the experiment carried out in 1930-31 in compartment 71 of the Bija High Forest Working Circle in Singpur Range, when the dense bottom storey of *karra* (*Cleistanthus collinus*) was clear felled to test the effect on natural regeneration of *bija*, results were found to be fairly satisfactory when the compartment was inspected on 1st February 1932 as the *bija* regeneration on the ground seemed to be responding to the extra light. The stools of the felled *karra* had put out coppice shoots abundantly, but these had been damaged by browsing of *nilgai*.

Hardwickia binata.—A third local plot has been laid out in the Bhujwa block (Nimar), in consultation with the Silviculturist, with the object to find out the effect of winter fellings on reproduction of *anjana* coppice.

(ii) *Pasture experiments.*

In order to obtain definite information as to the effect of grazing on pasture land in reserved forest a series of tests was carried out in consultation with the Directors of Agriculture and Veterinary Services. The grass on some 300 plots of $\frac{1}{10}$ acre each was cut and weighed to ascer-

tain the yield under various conditions. The season was abnormal and the results do not justify the drawing of definite conclusions. They tend to show that after constant grazing for a number of years the pasture deteriorates but recovers after a period of closure to grazing and further tests will now be undertaken to determine the number of years of grazing and closure which will give the best yield.

(iii) *Provincial—General.*

Under advice from the Central Silviculturist several of the old experimental plots were either transferred to the local list or closed or abolished. In all, there were 27 experimental plots on the provincial list at the end of the year: their territorial distribution is as under:—

Northern Circle	.	.	.	.	.	.	.	.	.	3
Southern	.	.	.	.	.	.	.	.	.	13
Berar including Research Division	.	.	.	.	.	.	.	.	.	10 + 1
										(permanent L.P.)
										<hr/> 27

The six *senal* (*Bombax malabaricum*) plantations of 1929 were maintained and are on the general list. Under an all-India co-operative scheme, 13 teak plantations (12 in old North Raipur and 1 in Betul) from six different seed origins were started in June-July 1931 and brought on the provincial list.

A new experimental plot No. 5 was laid out over 2 acres in the Allapilli Teak High Forest in order to determine whether repeated annual firing would induce any natural regeneration: the preliminary enumeration revealed that the existing teak seedlings represented a bare 10 per cent. stocking in sub-plot A (which is to be burnt annually) and about 4 per cent. stocking in the control (sub-plot B) area.

The *tavngya* plots at Allapilli (E. P. No. 3) and Sironcha (E. P. No. 4) were extended by adding 2.5 acres to the latter area.

Experimental Plot No. 3 (Chhindwara, 4 acres) was laid out in January 1928 in an attempt to obtain natural regeneration in refractory type of forest. Growth of teak coppice and bamboo is excellent, but the seed bearers of teak (28) and *shisham* (2) have produced hardly any seedlings so far.

Experimental Plot No. 5, Chhindwara, was closed after being under observations since February 1928. This represented an attempt to demonstrate *regeneration fellings* in a valley type of forest. The coppice reproduction of teak and miscellaneous species had been splendid, but the scattered seed bearers of teak, *bija* and *saj* had entirely failed to stock the area. Grass had invaded the plot and no natural seedling

of these species could be seen even after 4 years though the seed bearers were all healthy. Teak coppice, however, attained an average height of 20' and the miscellaneous species of about 10-15 feet during the period. The treatment accorded appears to be suited only for coppice reproduction, but secures little or no seedling regeneration. The seed shed by the standards has little chance of developing beyond the seedling stage.

Experimental plot No. 1, Research Division, was laid out in the plantation at Betul with the object of obtaining natural regeneration of teak with the help of closure to grazing and soil working (light ploughing) under almost a closed canopy. Teak seedlings appeared in thousands during 1931 rains both in the ploughed and unploughed areas. Enumeration was made in January 1932 and it was found that a fairly large number of seedlings had disappeared since last September but recruitment was assessed at 85 per cent. full stocking with ploughing and 64 per cent. without.

Closure to heavy grazing appears to have helped the natural regeneration, because in 1930 (before the closure) the area carried hardly any seedlings.

Under a scheme for an all-India investigation, the formation of teak plantations from six different seed origins was undertaken by the Silviculturist. Two sets of experimental plantations, each consisting of six plots, were commenced during April 1931 in compartment No. 309 of Sonakhan Range. Plots of about 0.5 acre each were laid out on gneiss and schist soils. The forest cover of good III C. P. quality with abundance of bamboo underwood—but with no teak in the forest—was clear felled and burnt. The seed obtained was sown in a nursery and the planting was carried out very successfully during the 1931 rains.

A teak plantation of about 0.5 acre was created during July 1931 by the Silviculturist at Baretha (Betul) in order to carry out a short term investigation to study the influence of 6 different origins of teak seed on the relative height and diameter growths, shape and size, seasonal development and hardness, etc., of the plants. The work was organised according to the Central Silviculturist's instructions.

(iv) *Statistical Work.*

a. *Sample plots.*

The total number of "crop increment and volume per acre" plots maintained on the provincial list has been reduced to 86 as some of the plots were abolished and others transferred to the "tree increment" list. One old plot of *Anogeissus latifolia* (S. Chanda) in the unevenaged mixed high forest of Kanhargan was reconstituted as sample plot

No. 5 with the help of the Forest Research Institute field party. The territorial distribution of the plots is as under :—

Northern Circle	16	} = 86
Southern "	.	.	.	.	.	.	.	56
Berar "	.	.	.	.	.	.	.	14

Only one plot of volume increment for *Chloroxylon swietenia* in the Hoshangabad Division could be measured during the season.

b. Tree Increment Plots.

In all, 5 plots, 4 in Southern Circle and one in Berar Circle, of *Chloroxylon swietenia* (1), *Shorea robusta* (3) and *Tectona grandis* (1) were transferred under this head from the sample plot list.

c. Outturn Tables in the Round for Teak (*Tectona grandis*).

Locality.—Allapilli Range (South Chanda).

Teak outturn tables in the round have been compiled from the data extracted with the help of the Forest Research Institute Statistical party from the Allapilli marking, felling and logging registers.

d. Stump Analysis.

Teak data collected in North Mandla were sent to the Forest Research Institute where the results were compiled for the use of the Working Plans Division.

The collection of *semal* (*Bombax malabaricum*) and teak data in the North and South Chanda Divisions and the laying out of a 6½ acres Sample Plot (No. 5) in the unevenaged mixed crop of South Chanda Division were made possible through the assistance tendered by the field party from the Forest Research Institute.

e. Nursery Work.

The *dona* system planned at Balaghat Forest School and then in Bilaspur has proved very successful and a brief summary may here be of general advantage. The leaf cups are easily prepared anywhere in the country; the seedlings, as soon as they put on a second pair of leaves in about 2-3 weeks after germination, are picked out from seed beds with the help of a bamboo splint and are put into *donas* filled with good soil. The *donas* are then kept under the *manda* shade and watered and casualties replaced from time to time. At the break of rains the plants, which are then 4"-8" high and have 5 or more pairs of leaves, are carried by coolies on *kawars* to the plantation sites, each man carrying 30 to 40. The *dona* leaves are then removed and the teak plant growing securely in the earth ball

is placed in the 6" wide and 9" deep prepared pits without the slightest disturbance to the root and the pit is then filled up.

Research Division (Betul-Balaghat). General.—The experimental and Demonstration areas and Nursery at Betul were maintained till the 16th January 1932 when the headquarters of the Silviculturist were transferred to Balaghat. The observations recorded up to date are detailed in the following paragraphs. Two plots measuring 170'×130' and 125'×45' have now been taken up in the Forest School compound at Balaghat for purposes of demonstration.

Demonstration area (Betul).—Out of nine species tried last year only six had become established: *bija*, *anyan* and *chir* disappeared completely. The broadcast sowings of mixed species carried out during 1930 in a patch of 90'×96' and kept under restricted grazing during 1930-31 showed the following results in August 1931:—

Survivals—Teak, <i>shisham</i> and <i>Gmelina</i>	. . . . .	(Frequent).
<i>Bija</i> , <i>Hardwickia</i> and <i>Tephrosia</i>	. . . . .	(Occasional).
Fresh germination (from 1930 sowings)—Teak and <i>shisham</i>	. . . . .	(Frequent).
<i>Samal</i> and <i>Tephrosia candida</i>	. . . . .	(Occasional).

Several species were planted out during 1930 in pits or ditches prepared to about 12" to 18" depth, and *Tephrosia candida* seed was sown all round. The latter grew splendidly and proved an excellent nurse protecting very successfully every single plant growing under its cover throughout the very dry summer with little or no watering. The plants developed vigorously with its help and in certain cases overtopped it in the second season.

Demonstration areas (Balaghat).—An area measuring about 0.5 acre has been taken up to demonstrate the possibility of creating mixed crop plantations with *Tephrosia candida* as a nurse. Accordingly, line sowings (in the direction of north to south) of seventeen species have been made in twenty-three rows, 6, 7 or 8 feet apart, with *Tephrosia* seed sown in twenty-five intermediate and peripheral lines. The seed lines have been hand-sown after ploughing and thorough working of the soil from 6" to 9" depth and 9"-12" width.

Another area measuring about 0.1 acre has been utilised for patch sowings with the object of demonstrating the possibility of increasing the percentage of useful and valuable species in a poor forest or to fill up blanks in any high forest.

Nursery : Germination tests.—Experiments were continued to ascertain the germination per cent. *in situ* and subsequent development of seedlings of a few species.

Germination tests *in situ* were made with seed of *Bombax malabaricum*, *Terminolia arjuna* and *T. tomentosa* collected under different conditions,

viz., either picked from the tree or collected from ground after it had fallen naturally. Better results were obtained from the fallen seed for *T. arjuna*.

Seasonal growth.—Observations were continued to determine the general development and height growth of various species grown in the last two seasons.

Tephrosia candida (*bogamedeloa*) continued to grow vigorously, in height and laterally, attaining a maximum height of about 6-7 feet in about 15 months after sowing. The plant flowered profusely during July-August. Pods were collected in October-November just before they dehisced and were dried before taking out the fertile seed. The seed collected at Betul was sown in 6"-9" deep prepared ditches at Balaghat in the second half of February 1932 and was watered daily. It germinated fairly well and several plants reached a maximum height of 2 feet by the end of June, the average height being between 6"-9" in 4 to 1½ months. Most of the seed lying dormant has now germinated with the help of recent June showers. *Tephrosia candida* has proved an effective and excellent nurse since its introduction in the Central Provinces in 1930 and its use in forest plantations (where it should be sown in intermediate lines running north to south) is hence strongly recommended.

(v) Miscellaneous.

(a) Climbers and Weeds.

Mahul (*Bauhinia vahlii*).—Observations made in Betul are instructive. It was pointed out last year that this climber is a pest to all the Low Forest Felling Series along the Amla Plateau. In one coupe alone 36,000 climbers have been cut over an area of 130 acres; in fact the climber represents the greatest part of the growing stock. The mistake has been to cut the climbers during the cold weather and then to fell the coupe in the next rains. The only way to gain headway with the climber is to cut the climber some 4 or 5 years ahead of working, so that the climber is cut under shade, several times if necessary. The clear felled areas of Mowar Low Forest Felling Series present an appalling spectacle; the forest seems to have been totally ruined. It had been suggested to let young cattle browse on the succulent shoots in the hot weather, but the Range Officer reports that the climber appears to thrive on this procedure. The more its young shoots are eaten, the harder and faster it grows; it remains to consider whether goats could deal with this plant.

In South Raipur many of the compartments in which regeneration fellings had been done were infested with climbers particularly *Bauhinia vahlii*, and compartment 194 of Sitanadi Range in which climber cutting

had been done in 1930-31 was again so infested with climbers after only one year that climber cutting had to be carried out again.

Siharu or Sirali (Nyctanthes arbor-tristis).—In Nimar, the removal of *sirali* has been allowed on payment of low royalty. Teak and other species in the forests of Punasa Range and Chandgarh reserve are reported to have definitely responded to the removal of this thick cover.

In South Chanda the burning operation in Allapilli and Pedigundam Ranges are reported to have resulted in a general clearing of the ground cover. Weeds and undergrowth are appreciably less dense and teak regeneration conditions have improved considerably, areas which were devoid of seedlings now containing them.

(b) Fire.

In Yeotmal it is recorded that whereas early fires in damper localities, such as valleys and areas along big streams, are often useful and help regeneration, fires in drier areas, such as tops of plateaux are positively harmful. The striking difference in teak natural regeneration in Selwa and Pandratola Blocks (Balaghat) where other factors are strictly identical is attributed to the fire protection and restrictions in grazing.

The Khandesh system of fire protection was tried in Nimar and Bhandara Divisions with indifferent results. Whereas there appears to be nothing wrong with the system itself, it was found well nigh impossible in the lightly grazed areas of Kalibhitis to put a fire inwards towards the roads without its extending outwards as well. Cutting of guide lines will be tried next year.

(c) Grazing.

Recent government orders have led to all reserved forests being provisionally sub-divided into two classes Tree Forest and Pasture Land. The question of rotational closures is now receiving attention and in the recent grazing settlements made in Bilaspur and the two Mandla Divisions this important matter has received the attention of the Special Revenue Officer.

In Yeotmal the necessity of periodic closures in heavily grazed areas in the interests of both pasture and tree growth is emphasised ; 5 years' closure after every 10 years of grazing has given much better results than 10 years' closure after 20 years' grazing. It is suggested that a three years' closure after 7 years' grazing would be a very suitable period for the restoration of pasture. It is possible that the opening of normally closed coupes for certain months of the year will help coppice shoots in Mahasamund Range of North Raipur Division to overcome the luxuriant growth of grass which hampers their development.

(d) *Frost.*

In Sangor the forests in the north now show a marked recovery after the severe frost of 1929; the Garhakota Rannua forests, however, do not show much improvement. The seeding of forest species in Sangor is reported to have been excellent and it appears certain that this year's good monsoon has contributed considerably to the recovery of the forest from the adverse effects of the 1929 frost.

South Mandla reports that owing to freedom from severe frost in the last 2 years, *sal* regeneration is shooting ahead. The young *sal* growth around Sathin and between Sajalgaon and Sathin has however again been frosted back, but it is battling with adversity and will in time probably become established. Minor frost damage is said to be noticeable along the banks of the Pench and the Kanhan rivers in Chhindwara Division.

(e) *Drought.*

Due to the general excellence of monsoon rains, seeding regeneration and coppice reproduction as well as bamboo growth enjoyed very favourable conditions with a longer period of growth than usual.

(f) *General.*

Records.—The library had an addition of 44 publications. General files were opened for 23 new subject heads and one specific file was added during the year. Additions were made to the photographic collection.

A detailed statement of the permanent silvicultural records is as under :—

Permanent Silvicultural Records (excluding the plot files).

Year.	LIBRARY BOOKS.		LEDGER FILES.				PHOTO COLLECTION.		NEGATIVE COLLECTION.	
	New.	Total	GENERAL SPECIFIC.				GENERAL AND SPECIFIC PRINTS.		GENERAL AND SPECIFIC.	
			New.	Total.	New.	Total.	New.	Total.	New.	Total.
1929-30 .	..	.	..	10	..	41	..	136	..	42
1930-31 .	..	248	40	50	3	44	129	265	58	100
1931-32 .	44	292	23	73	1	45	20	201	20	120*

* 72 full-sized prints of general forest interest have recently been indexed for from the Forest Research Institute, Dehra Dun.

II.—WORKING PLANS AND STATISTICS.

(a) *Alterations to existing Schemes and Working Plans.*

A number of working plans were amended and in the course of the year the enquiry ordered by Government in 1928 to be carried out in North Chanda with a view to improving the grazing incidence in certain units was carried out. The restrictions are to be introduced with effect from the 1st July 1932.

(b) *New Working Plans.*

Working Plans have been sanctioned for the following forests :—

Allapilli-Pedigundam and Chhindwara.

Jubbulpore-Narsinghpur and Bhandara.

Bailhar-Supkhar.

A plan has been prepared for the Nimar forest and plans are in process of preparation for the following :—

Bilaspur.

South Mandla.

North Mandla.

Saugor.

Nagpur-Wardha.

(c) *Control.*

Some defects of recent plans or in their application are now becoming evident. In Betul the allotment to the High Forest Working Circle and to Periodic Blocks is capable of improvement ; there is a tendency to reduce the growing stock to that of a pure teak forest and to retain too many seed bearers, while insufficient attention has been paid to the removal of bamboos.

In *North Chanda*, owing to a lack of demand for firewood, fellings are not sufficiently heavy to establish a new crop, and where there is a heavy growth of bamboos this will need to be dealt with.

In *Seoni* the stock-mapping is not very accurate and some forests are too poor for coppice.

In the *Jubbulpore-Narsinghpur* Teak High Forest Working Circle the reservation of scattered seed bearers has been of little use. Where seedling regeneration is needed it would seem better to postpone heavy felling until seedlings are on the ground. Some crops are too poor for the coppice system which has been prescribed.

In *North Raipur* the coppice with standards system seems unlikely to fulfil expectations in some forests, and the thinning of coppice is of doubtful utility where the stock is poor. The latter observation is also recorded in *South Raipur*.

(d) *Future work.*

The Working Plans for the Amraoti, West Berar and Dandoh Divisions are quite obsolete. New plans for the important teak forests of the Melghat Division, the forests of the Sironeley, Dhalda, Markhanda and Ghot Ranges of South Chanda Division, and the mixed ranges of Balaghat are required early. The South Raipur S. / Forest Plan will have been in operation for 10 years on the 30th June 1934 so its revision cannot be much longer delayed and experience gained from the actual working of the Betul Working Scheme during the past five years have shown that it is far from satisfactory. Revision of these working plans should be taken in hand as early as possible so that they may be ready when the inevitable recovery from the present slump in the timber market comes.

MADRAS.

I.—EXPERIMENTAL SILVICULTURE.

(i) *General.*

Nilambur as one of the main centres of research has been replaced by a station opened in the Wynnad. A new research range has been formed with headquarters at Chittoor, for work in the "dry" districts. Several new experimental gardens for carrying out stage I (a) investigations under carefully controlled conditions have been opened. A start has been made in using methods of statistical analysis for assessing the "significance" of observed differences.

(ii) *Natural Regeneration.*

A new set of plots for the study of measures necessary for bringing up existing natural regeneration of *Hopen purrylora* has been opened. It has been found that *Strobilanthes (reticulatus?)*, a troublesome weed in many evergreen forests and a great impediment to natural regeneration, can be destroyed as effectively by cutting it above ground level as by cutting it at ground level and severing the aerial roots. The former method is of course considerably cheaper.

(iii) *Seeds.*

Reporting the seeding of principal species by districts has been put on a more satisfactory basis. Systematic seed tests have been carried out mainly at Chittoor with species intended for use in improving the poor dry fuel forests common in many districts of the presidency. Investigations into the effect of seed origin have been continued, and new plots have been opened as part of an All-India investigation into this subject (with teak), initiated by the Central Silviculturist. Indications at present seem to be in favour of the use of local seed in a given locality.

(v) *Artificial Regeneration.*

Stocking of felling gaps.—Much work is being done in several districts (by the district staff) both in evergreen and deciduous forest. Success is not yet claimed, but the work shows more promise than many observers thought possible.

Direct sowing.—"Rab" sowings in fuel coppice coupes are being carried out in most districts where this type of forest is found and the results are giving indications of the lines on which to work in improving, or saving from further deterioration, this type of forest.

Manuring.—The addition of lime to the soil in areas artificially regenerated with teak and rosewood appears to have had no effect, beneficial or otherwise.

Drainage was successfully employed in a swampy area under artificial regeneration with teak, but the cost was prohibitive.

Weed control and soil aeration.—In last year's report it was stated that the results of certain experiments appeared to show that "scraping" (i.e., removing the weed growth without disturbing the soil) had an effect on the growth of a young teak plantation as beneficial as a deep fork-weeding involving a thorough aeration of the soil. A more carefully designed experiment conducted this year shows (subject to confirmation by repetitions) that this belief is a mistaken one, the difference in favour of fork-weeding being, as might be expected, distinctly significant.

Stump planting.—The results of the trials of this method of artificial regeneration with a number of species are recorded. Worth special mention are the excellent results obtained with rosewood and *Terminalia paniculata*.

Several plots dealing with the optimum season and method for stump planting are described. It appears that given luck in the matter of pre-monsoon showers planting stumps in April or May can give excellent results and considerable added height growth in the first year. But early planting is a gamble in the rain, and a departure from the normal practice of planting with the first real monsoon rains is not, on our present

knowledge, recommended. Between planting in "pits" and planting in "crow bar holes" differences are often not significant, but taking all results together there is probably a slightly increased height growth with pits. It is unlikely, however, that this slight advantage of pit planting can justify the greater cost of pitting.

The Forest Botanist's report on his examination of a number of specimens sent to him goes far to dispel the fear expressed by some observers that teak grown from stumps is liable to be unsound.

Cuttings have been tried with various species both by the Silviculturist and by the District Forest Officers. Results have been uniformly unsuccessful.

Cover crops.—*Tephrosia candida* and *Centrosema pubescens* have been introduced in young teak plantations at Nilambur. *Tephrosia* is of doubtful benefit, and *Centrosema* is definitely harmful as it develops into a troublesome climber.

Miscellaneous.—Cashewnut (*Anacardium occidentale*) is extremely easy to raise at Nilambur on poor shallow laterite by direct sowing.

(vi) *Reclamation and Afforestation.*

Nil, though much of the work done in trying to improve the poorest type of scrub fuel forest might be classed under this head.

(vii) *Thinning and Cleaning.*

An experiment by the District Forest Officer, Lower Godavari, indicates that the routine mechanical thinnings now being made in young plantations of *Casuarina equisetifolia* are preferable to thinnings made according to "silvicultural requirements."

(viii) *Mixtures and (ix) Underplanting.*

Experimental work is mainly concerned with teak plantations. Attempts at rather elaborate mixtures have given unsatisfactory results. Underplanting is receiving less attention than formerly. Earlier work has shown that underwoods of various species can be introduced at a price, but experience now points to the belief that with a careful encouragement of all woody growth from the time of the first weedings onwards an adequate underwood and moderate degree of mixture can be obtained without recourse to artificial methods. Some work continues, mostly with bamboo, and *Cephalostachyum pergracile* is giving encouraging results.

II.—WORKING PLANS AND STATISTICS.

(i) *Working Plans.*

The Provincial Silviculturist is in touch with Working Plans Officers, and Silvicultural and Statistical prescriptions are referred to him from time to time.

(ii) *Yield Tables.*

Eighty-one permanent sample plots were maintained and those due for remeasurement were measured.

(iii) *Volume Tables.*

A considerable number of local Volume Tables were prepared and progress was made in the collection of data for others.

(iv) *Bark Measurements* and (v) *Miscellaneous.*

The only bark measurements are those made in the course of sample plot re-measurements. Ring countings on systematic lines have been started in felling areas at Mount Stuart.

III.—MISCELLANEOUS.

All the Ledger files (344 specific and 60 general) have been re-arranged on Howard's system. Twenty-eight new experimental plot files have been opened and 63 have been written up and closed.

Two areas have been set apart for permanent preservation of forest types and action is being taken in respect of a third.

PUNJAB.

I.—EXPERIMENTAL SILVICULTURE.

(i) *General.*

The first Triennial Research Programme for the period 1931-32 to 1933-34 was sanctioned and circulated.

A programme for the year was based on this and was closely followed. It has been decided for the present to concentrate the experimental field work to be done in (i) Kulu Forest Division for *Cedrus deodara* (deodar), *Pinus excelsa* (kail), *Picea morinda* (spruce), *Abies webbiana* (silver fir) and their broad-leaved associates of economic and silvicultural importance, (ii) Kangra Division for *Pinus longifolia* (chil). (iii) Kangra and Hoshiarpur Divisions for *Dendrocalamus strictus* and other bamboos.,

(iv) Chichawatni Irrigated Plantation for irrigation experiments and for *Dalbergia sissoo* (*shisham*), *Morus alba* (mulberry), *Eucalyptus* spp., *Tamarix articulata* (*frash*), *Prosopis spicigera* (*jand*); *Acacia catechu* (*khair*) and other plains species to be introduced in the irrigated plantations, (v) Lahore Division (Jhok and Shahdara Reserves—riverain forests) for *Populus euphratica* (*bahan*), riverain *shisham* (*Dalbergia sissoo*), mulberry (*Morus alba*) and *Bombax malabaricum* (*simal*), and (vi) Sambhalpani in Kalaohitta R. F. or Chola Saidan Shah in the Salt Range for *Olea cuspidata* (olive), *Acacia modesta* (*phulai*) and other low hill species.

(ii) Natural Regeneration.

Spruce and silver fir reproduction.—The Research Officer made a preliminary survey of the spruce and silver fir forests in the Beas and Parbatti valleys of the Kulu Division with a view to classify them into broad recognizable types and to study the factors both favourable and unfavourable to the natural regeneration of the two firs. Several main types have been distinguished and interesting observations have been made regarding the depth of humus in different vegetational types and the presence or absence of natural spruce and silver fir regeneration there.

Abundant natural regeneration of both spruce and silver fir exists (i) where the mineral soil has been exposed either naturally through landslips and snow slides, or artificially through roadside cuttings, scraping of litter, removal of felling refuse and humus (by burning or otherwise), or hoeing the ground in patches, (ii) where the shrubs and weed growth are scanty either because of excessive grazing or medium overhead cover, (iii) where the undergrowth consists of scattered *Indigofera gerardiana*, *Desmodium tiliacifolium* or *Viburnum foetens*, (iv) where the underwood is composed of an open forest of broad-leaved trees such as *Aesculus indica*, *Acer pictum*, *Corylus colurna*, *Alnus nitida*, *Ulmus wallichiana*, etc., (v) where the ground is sloping and well-drained, and (vi) where the canopy is naturally broken either in small narrow strips or in small patches, or where it has been artificially but moderately opened.

Profuse natural regeneration of silver fir with a fair mixture of both spruce and *kail* has been obtained in Pulga, Kalga and Nakas blocks of forests (Parbatti valley, Kulu Division) felled over under the shelterwood compartment system in 1915-16 to 1917-18, wherever the debris and humus were burnt, the soil was worked and closure to grazing was enforced.

The inimical factors to the natural regeneration of both spruce and silver fir, therefore, seem to be :—

- (i) thick layer of humus,

- (ii) accumulation of debris,
- (iii) heavy growth whether of weeds or shrubs,
- (iv) heavy opening of the canopy either under shelterwood or in gaps or in strips,
- (v) heavy uncontrolled grazing, and
- (vi) bad drainage.

It is probable that light to medium opening of the canopy (about 25'-30') in the case of silver fir and (about 40'-50' in the case of spruce), retaining an underwood of broad-leaved trees wherever possible, accompanied by the burning of humus and felling refuse, will yield regeneration in a good seed year; this must be followed by soil working and closure to grazing, and in due course by thorough weeding until the plants are established; later the controlled grazing of horned cattle may be beneficial. To arrive at definite conclusions, 34 experimental plots, 26 in Kulu and 8 in Lower Bashahr Division, have been laid out to study the natural regeneration of the two firs under different intensities of fellings, in clear-felled strips of different widths alternating with unfelled strips running in different directions, and in gaps of various sizes, with manipulations of humus, felling refuse, undergrowth, soil, burning and grazing. Since the close of the year, the Kulu plots have been inspected by the Central Silviculturist with whom methods of laying out quadrats and indicator plots and the technique of the assessment of existing regeneration and its further influx were discussed.

The following types of the spruce and silver fir forests have been tentatively distinguished :—

(i) *Spruce fir.*

(i) *Hardwood type*, where spruce fir is associated with broad-leaved trees such as *Aesculus indica*, *Juglans regia*, *Acer* spp., *Celtis australis*, *Ulmus wallichiana*, *Populus ciliata*, *Symplocos crataegoides*, etc.

(ii) *Low level mixed type*, where spruce fir is found mixed with blue pine or deodar or both.

(iii) *Indigofera-cum-Desmodium-cum-bracken fern type*, where undergrowth consists mainly of *Indigofera gerardiana* and *Desmodium tiliaefolium* with a dense mass of bracken fern growing underneath them.

(iv) *Spiraea-cum-Viburnum-cum-bracken fern type*, where undergrowth is mainly composed of *Spiraea sorbifolia* and *Viburnum foetens* with a dense mass of bracken fern and scattered *Salvia glutinosa* growing under them.

(v) *Iris-cum-Viburnum-cum-Spiraea* type, where *Iris nepalensis* carpets the ground with *Viburnum foetens* and *Spiraea sorbifolia* growing thinly over it.

(vi) *Plectranthus rugosus* type, where undergrowth is chiefly composed of this shrub.

(vii) *Senecio* type, where *Senecio rufo-erectus* forms a dense ground cover with and without *Ainsliaea aptera* scattered through it.

(ii) Silver fir.

(i) *Bhojpatra* type, where a stunted form of silver fir grows scattered amidst *Betula utilis*. This is the highest level silver fir type and lies entirely outside the economic zone.

(ii) *Kharsu* type, where silver fir is growing mixed with *Quercus semecarpifolia* at high elevations. This type is also not of any economic importance in Kulu.

NOTE.—A distinct *Harau-Abies* type of silver fir forests is met with in the Outer Himalayan Range in Kangra Division where rainfall is comparatively much heavier than in Kulu, e.g., silver fir forests of Dharmasala and Palampur Ranges. This type is not met with in the Beas and Parbatti valleys of Kulu Division.

(iii) *Pure silver fir* type, where silver fir grows pure or with a little admixture of over-mature spruce fir. This type is confined to cool northern aspects.

(iv) *Kail* type, where silver fir is found mixed with over-mature *kail* (*Pinus excelsa*) and spruce (*Picea morinda*). This type is characteristic of the head of the Parbatti valley and is prevalent on the north-east and north-west aspects. It is entirely absent in the Beas valley.

(v) *Yew* type, where yew forms a thick undergrowth to mature and over-mature silver fir forests. This type is confined to sheltered depressions on northern slopes.

(vi) *Hardwood* type, where silver fir is found growing mixed with broad-leaved trees such as *Aesculus indica*, *Acer pictum*, *A. cacsium*, and *A. candatum*, *Prunus padus*, *Ulmus wallichiana*, *Juglans regia*, *Populus ciliata*, etc.

This type occurs at the lower limits of silver fir generally in depressions and along *nala* banks.

(vii) *Nirgal* type, where *Arundinaria spathiflora* forms conspicuous undergrowth in silver fir forests, e.g., silver fir forests in Mohalkhad valley.

In the above main silver fir types, several sub-types based on shrubs and weed growth can be distinguished though very often they merge into one another.

Observations tend to show that a light cover of broad-leaved trees and sparse undergrowth of *Desmodium tiliacifolium* and *Indigofera gerardiana* are favourable to the natural regeneration of both spruce and silver fir. The humus formed by them is not injurious nor is it so thick as to retard regeneration. Grazing and removal of coniferous needles are helpful in exposing the mineral soil and keeping down the weed growth thereby assisting the natural regeneration of the two firs, but they retard the subsequent development of the seedlings and should therefore be stopped for about 10 years immediately natural regeneration has made its appearance.

Soil samples for every 6" depth down to 2½' were taken in various vegetational types of spruce and silver fir forests, but they could not all be analysed at the Forest Research Institute. The roots of trees and shrubs were found not to grow deeper than 2 to 3 feet.

Kail (Pinus excelsa).—An experimental plot has been laid out in Kalga (Parbatti valley) to study the natural regeneration of *kail* at high levels where it has been failing for one reason or another since the areas were brought under regeneration in 1916-17. The felling refuse, humus, weed growth and soil are being subjected to various treatments and effective closure is being enforced.

Deodar (Cedrus deodara) closure to grazing and removal of litter.—Experimental Plots 1-3 and 5-7 of Kulu Division, started in 1914 by the Forest Research Institute in co-operation with the then Divisional Forest Officer, have definitely proved that in a pure deodar or mixed deodar and blue pine, deodar and spruce, or deodar, blue pine and spruce forests, after opening the canopy for regeneration, effective closure to grazing and removal of litter is essential for successful natural regeneration of the above species. The areas thus closed are now fully regenerated while there is nothing outside, although at the time when the experiments were started there were masses of germinating seedlings both inside and outside the plots. The above experiments having served their purpose have now been closed down.

Kalesar clear felled experimental plot—sal, etc.—In Kalesar R. F. C. 14, an area of 20 acres containing an old worthless crop of *sal* and its associates was experimentally cut back in 1930 with a view to study its natural regeneration from coppice, etc., after burning the rank growth. The frost and deer browsing are reported to have destroyed the young coppice shoots and seedlings that came up.

Dendrocalamus strictus.—In both Bindraban and Karnpur bamboo forests of Hoshiarpur Division profuse natural regeneration of bamboo has resulted from seed from flowered clumps. It is reported to be especially good under flowered clumps. It has also been observed in Hoshiarpur bamboo forests that production of young shoots is superior

both in number and quality in properly cleaned clumps than in congested ones.

Reproduction of riverain sissoo (Dalbergia sissoo) from root suckers.—It has now been definitely proved that the best method of obtaining *sissoo* natural regeneration from root suckers is digging 1'×1' circular trenches 10' apart round the stumps or in straight lines where sufficient *sissoo* trees are growing. This is now the usual practice in the riverain forests of both Lahore and Multan Divisions.

(iii) *Seeds (collection, weight germination and plant per cent., etc.).*

Seed indents and supplies.—The Research Division now acts as a clearing house for seeds; all seed indents from various divisions, provinces and foreign countries were met.

(i) *Seed experiments—(Cedrus deodara). Effect of locality on the colour and size of deodar seed.*—No marked difference in size of the seed collected in Kulu and Seraj Divisions (wet zone) and Upper Bashahr and Kagan Divisions (dry zone) was noticed. As regards colour, seed from Kulu and Seraj Divisions (wet zone) was alike, viz., dark brown and different from that of Kagan and Upper Bashahr (dry zone) which are both similar in colour, viz., reddish brown. (ii) An investigation was started to ascertain the effect of size and general condition of the trees on germination and plant percentage in different localities.

(i) *Pinus excelsa.*—Germination percentage with different treatments and different soil media in boxes indicated that a mixture of *bryri* sand and forest soil is the best medium for germination. There does not seem to be any significant difference in germination percentage as regards the pre-treatment of seed sown in boxes under control, except that soaking for 12 hours followed by drying in the sun for six hours results in a lower germination percentage. Germination percentage for all treatments worked out to be 82 per cent.

(ii) *Germination and plant percentage with different treatments in nursery beds with same soil.*—With treated *kail* seed sown in experimental nursery beds germination commenced on 17th July 1931 and ceased on 31st October 1931. The best percentage was obtained by soaking the seed for 48 hours.

(iii) *Effect of elevation and locality on the size and colour of seed.*—*Kail* seed was collected at different elevations in the Parbatti and Beas valleys, Kulu Division, and in both cases that collected at about 7,000' was the biggest and best developed.

(iv) *Effect of size of trees on germination and plant percentage.*—*Kail* seed was collected from trees of various diameter classes and sown in nursery beds at Mannali.

(v) *Effect of elevation on germination and plant percentage, and seedling development.*—Kail seed was collected at various elevations from 4,800' to 9,000' in various localities for trial next season.

Spruce (Picea morinda).—To study the effect of the size of trees on germination and plant percentage, spruce seed collected from trees of various diameter classes was sown in nursery beds in Inner and Outer Seraj Ranges of Seraj Division. The seeds collected from trees of 24"-26" diameter have given the best germination and plant percentages, seeds from 18"-23" and 27"-29" diameter trees closely following them. These experiments are being repeated in the experimental nurseries at Manali and Kaisdhar to confirm or modify the above conclusions.

Silver fir (Abies webbiana).—Germination and plant percentage experiments are in progress.

Aesculus indica.—To see the effect of the size of seed on germination, plant percentage and development, horse-chestnut seed was sorted into two sizes (i) $1\frac{1}{2}$ " and over in diameter and (ii) under $1\frac{1}{2}$ " diameter, and sown in Manali experimental nursery beds. There is already a marked difference in the growth of plants.

Frazinus micrantha—*Pretreatment of seed.*—Seed obtained from Parbatti valley and Siran Division was sown on 16th December 1931 (i) without removing the scale and (ii) after removing the scale and (iii) stratified, with a view to hasten germination. The seed has not yet germinated.

Populus euphratica.—Poplar seed collected in July 1931 in Multan Division was sown in August in a variety of soils, but the germination per cent. obtained was very low.

Prosopis juliflora.—Pods collected from trees in Lahore in September 1930 were stored in gunny bags and sown on 20th August 1931 in a variety of soils. The pods were cut into segments and the seeds were sown without taking them out of the pods. The germination percentage was 52 in the case of pure leaf mould and 79 in heavier soil. Seed taken out of the pods and soaked for 12 hours did not give quite such good results. The above two experiments definitely prove that germination percentages are better in heavy soil than in light soil.

Frash (Tamarix articulata).—Seed collected in October 1931, November 1931, and January 1932 did not germinate.

In Khanewal Plantation, *frash* seed collected in the middle of November 1931, soaked in vinegar for four days, gave only poor results.

Effect of opening the canopy on seedling.—It has been observed in Seraj Division that deodar left in seedling felling in 1930 did not bear any seed in 1931, although it was a good deodar seed year. This confirms similar observations made in Kashmir in 1930.

Effect of the paucity of rain and snowfall on deodar seed and seedlings.—1931 was a good deodar seed year in all hill divisions, but it is reported that in Seraj Division, due to deficient rainfall in the monsoon, deodar seed though plentiful did not develop to its full size and that a fairly large quantity of it turned out to be hollow. Want of snow in the winter adversely affected both the natural and artificial deodar regeneration in Kulu and Seraj Divisions.

(iv) Nursery Work.

(a) Experimental research nurseries.

Experimental research nurseries (area about an acre) were started at Mamli, Kulu Division, at an elevation of 6,200'. The nursery sites are old deodar forests clear-felled some years ago and experiments are being made to determine the best spacing for deodar transplants and the effect of root and shoot pruning.

(b) Forest nurseries.

Mulberry (*Morus alba*).—Both in Daphar and Khanawal plantations, mulberry has been successfully raised from seed in nurseries. Light shade and constant irrigation seem essential in order to do so.

Bamboo (*Dendrocalamus strictus*).—In the irrigated plantations at Daphar, Chichawatni and Khanawal, bamboo has been successfully raised from seed sown in July in nursery beds; the beds were regularly watered and germination took place in about a fortnight. The seedlings had to be protected first against the sun and later against frost by means of shades. At the close of the year, the seedlings were about a foot high.

Ber (*Zizyphus jujuba*) and *semal* (*Bombax malabaricum*).—Nurseries of *ber* and *semal* were started in Lehtrar (about 4,000'), Rawalpindi East Division, to raise seedlings for root and shoot cuttings for planting in brushwood forests of Kulu Tehsil; good germination was obtained.

Eucalyptus nurseries.—The following *Eucalyptus* species were tried in Chofurgalla (5,000') and Lehtrar (4,000') Rawalpindi East Division: *E. rostrata*, *E. albens*, *E. tereticornis*, and *E. mallariana*. Of these *E. rostrata* and *E. albens* gave very good results and seedlings planted out during the rainy season have grown satisfactorily. Of the remaining three species, *E. tereticornis* germinated but grew badly, and the remaining two entirely failed.

(v) Artificial Regeneration.

Moungahar 2/6, C. I. and Hathipur 2/60, C. I. clear-felled areas have been constituted experimental plots for the study of the artificial regeneration of *Pinus excelsa*, *Picea morinda* and *Abies webbiana*.

Spruce and silver fir sowings and plantings.—Direct winter and spring sowings of both spruce and silver fir have been done both in nurseries and the forests. Monsoon sowings will now be done to determine what precise success is obtained with sowings at different times of the year.

*Bamboo (*Dendrocalamus strictus*) planting.*—A large number of one year old bamboo seedlings raised in nurseries have been successfully transplanted during the rains in Karnpur and Bindraban bamboo forests of Hoshiarpur Division. Seedling planting is cheaper and more successful than planting of rhizomes.

*Irrigated Plantations. (*Eucalyptus rostrata*).*—Pot planting of *Eucalyptus rostrata* in Changa Manga Plantation is being continued with success. A note on the cultivation of *E. rostrata* in Changa Manga Plantation embodying the established technique of its nursery practice and bottomless pot planting has been published in the *Indian Forester* for April 1932.

Trials with planting of *frash* shoot cuttings in Khanawal and Miranpur plantations have shown that April planting is more successful than August planting.

Substitutes for shisham in Khanawal Plantation.—In areas unsuited to *shisham* in Khanawal plantation, *ber* (*Zizyphus jujuba*), *bakain* (*Melia azedarach*), *dhak* (*Butea frondosa*), *khair* (*Acacia catechu*), *Acacia senegal* and *Acacia leucophloea* were sown and given 4' depth of water. *Acacia leucophloea* and *Butea frondosa* failed almost entirely; other species with the exception of *bakain* are doing well.

Irrigation experiments.—Depth of irrigation experiments initiated in co-operation with the Central Silviculturist in Chichawatni Plantation during 1928 to investigate the effect on height growth of *shisham* of different depths of water in different kinds of soil, were concluded in February 1932. The results of the analysis of the 1930 measurements confirm the conclusions reached in two previous years, viz., the depth of irrigation over the minimum given for different types of soil (good soil 3', average soil 4', *kallar* soil 7', worst *kallar* soil 9') is not accompanied by any gain in height growth.

Relative water loss from soils with different covers.—Three experimental plots to determine the relative water loss from soils due to grasses and trees were initiated in co-operation with the Central Silviculturist in Changa Manga Plantation in April 1931. Soil samples for every 6" depth down to 2½' are being taken three times in a year and their moisture content determined.

Cattle grazing in the irrigated plantations.—In order to reduce the intensity of grass obstructing the easy flow of water in the trenches,

the grazing of horned cattle was allowed experimentally in winter in the irrigated plantations in Montgomery Division. This has proved very satisfactory.

Cupressus torulosa sown at Dharmasala in wooden boxes filled with sandy loam soil and lightly covered germinated well.

Callitris glauca and *Eucalyptus crebra* tried in Khauewal Plantation gave very poor germination results while *Eucalyptus citriodora* did well.

Larix europea, *Larix japonica* and Douglas fir sown in Nakas forest of Kulu Division sometime in 1917-18 are growing remarkably well. They are now about 20' high. *Larix europea* and *Larix griffithii* are being raised at Manali for introduction in the zone just above deodar in Kulu Division. 8,000' is the most suitable elevation for larch in these hills. European larch seedlings raised in nurseries in 1929 in the Lower Bashahr Division, varied in height from 41" to 14' in December 1931, and 78 of the better grown seedlings are planted out in mixture with deodar.

(vii) Thinnings and Cleanings.

Comparative thinning plots.—A few more deodar comparative thinning sample plots were laid out in the Kulu Forest Division.

Root competition experiments.—Experimental plots, laid out in Upper Kulu Range, to study the effect of the elimination of root competition by trenching on (i) growth of surface vegetation and (ii) growth of deodar seedlings, already showed marked results; the vegetation being luxuriant and varied in the trenched plots while it is inconspicuous in the untrenched plots.

(xi) Miscellaneous (burning, poisoning, etc.).

Controlled burning in chil sapling crops.—Chil sapling crops 3' and over in height can be safely burnt under control after cleanings. Experiments are now being conducted in Rawalpindi East Division to determine the minimum size and the least spacing of cleanings at which it is safe to burn under control chil sapling crops under 3' in height.

Fomes annosus.—Experiments carried out in Seraj Division to prevent the spread of *Fomes annosus* in deodar plantations by deep trenching have once again failed. The remedy seems to lie in avoiding areas unsuitable for deodar and in growing mixed crops of deodar, *kail*, spruce, ash and walnut in groups of, say, about 150' × 150'.

Lantana.—Experiments to eradicate *Lantana* by grubbing out and burning carried out in Palampur have failed. The obnoxious weed is as rampant as ever in this neighbourhood.

II.—WORKING PLANS AND STATISTICS.

(i) Working Plans.

The new Koehi (Sutlej Valley) Working Plan was sanctioned by Government. The preparation of the following Working Plans was completed during the year :—

- (1) Working Plan for Kanawar forests (Upper Bashahr).
- (2) Revised Working Plan for Kangra Forest Division.
- (3) Working Plan for Chichawatni Plantation.
- (4) Working Plan for Tharoch State forests.

The following Working Schemes were prepared in Simla Forest Division and sanctioned by the Chief Conservator of Forests, Punjab and N. W. F. P. :—

- (1) Simla Catelmont Area forests.
- (2) Ghund forests.
- (3) Koti State forests.

The following Working Plans and Schemes are under preparation :—

- (1) Revision of Working Plan for Hoshiarpur Forest Division.
- (2) Revision of Working Plan for Kulu and Seraj Forest Divisions.
- (3) Working Scheme for Mailog State forests (Simla Division).
- (4) Working Scheme for Modhan State forests (Simla Division).

(ii) Sample Plots.

Sample Plots were maintained in good condition in all divisions.

The Forest Research Institute Sample Plot Party toured in Kulu and Seraj Divisions during the summer, laying out new sample plots for *Cedrus deodara* and remeasuring old plots. The Provincial Sample Plot Party was organised in the summer and trained in the technique of sample plot field work, both the Parties working together in Kulu Division. In the winter the Party toured the irrigated plantations and riverain forests of Lahore, Montgomery and Multan Divisions, remeasuring old sample plots of *Dalbergia sissoo* and *Morus alba* and laying out new ones for both these species as well as for *Populus euphratica*, and collecting data for firewood conversion factors.

The distribution of new sample plots laid out and the old plots re-measured during the year is as follows :—

Species.	Division.	New plots laid out.	Old plots re-measured.	Remarks.
<i>Cedrus deodara</i>	Kulu . . .	22	8	* Situated in the year's felling coupe and so completely measured before clear-felling. † Temporary plots.
<i>Ditto</i>	Seraj . . .	9	..	
<i>Pinus excelsa</i>	Kulu . . .	..	5
<i>Morus alba</i>	Lahore . . .	1	3 ^c	
<i>Dalbergia sissoo</i>	Do. . . .	3	..	
<i>Ditto</i>	Montgomery .	2†	4*	
<i>Populus euphratica</i>	Lahore . . .	1	..	
<i>Ditto</i>	Multan . . .	8	..	
Total	..	46	20	

(iii) Comparative thinning investigations.

To see the effect of varying thinning grades on total volume and timber production, comparative thinning investigations are in progress for *Cedrus deodara*, *Pinus excelsa*, *Pinus longifolia* and *Dalbergia sissoo*. The following comparative sample plots exist at present :—

Species.	Division.	No. of sample plots.
<i>Cedrus deodara</i>	Upper Bashahr	6
<i>Ditto</i>	Kulu	17
<i>Pinus excelsa</i>	Upper Bashahr	4
<i>Pinus longifolia</i>	Rawalpindi East	10
<i>Ditto</i>	Rawalpindi West	2
<i>Dalbergia sissoo</i>	Lahore	18
<i>Ditto</i>	Montgomery	11
<i>Ditto</i>	Multan	6

More comparative thinning sample plots for *Pinus excelsa* will be laid out in the Pabar valley.

The Provincial Statistical Parties worked both in the hills and the plains collecting data for volume tables. Altogether the following number of trees have been measured during the year :—

Species.	No. of trees measured for standard vol.	No. of trees measured for commercial vol.	Remarks.
<i>Cedrus deodara</i>	..*	..*	*Not including the trees measured by the Forest Research Institute Party in collaboration with the Provincial Party
<i>Pinus excelsa</i>	2*	2*	
<i>Abies pindrow</i>	24	24	
<i>Picea morinda</i>	31	17	
<i>Dalbergia sissoo</i>	747	..	
<i>Morus alba</i>	470	..	
<i>Populus euphratica</i>	225	..	

In addition to the above, 82 trees were measured by the divisional staff, 50 *chil* trees in the Rawalpindi West and 32 trees in Lower Bashahr.

Kulu Sawn Outturn Volume Tables for deodar, *kail*, *chil* and fir were checked against the total actual sawn outturn (aggregate check) in various forests of Kulu and Sernaj Divisions during the currency of the Plan (1919-1930) and were found quite satisfactory. It is now definitely known that the Kulu Volume Tables are based on $\frac{1}{4}$ girth volumes measured over bark.

(iv) Other Statistics.

1. *Stump analysis*.—Stump analysis of 16 silver fir trees was carried out in the Parbatti valley (Kalga, C. I., Section 1). Ring counting on 70 old deodar trees was also made, 41 in Upper Bashahr (Salarang) and 29 in Sernaj (Girchis) Divisions.

2. *Stem analysis*.—Stem analysis of 24 deodar trees was carried out in the Upper Kulu Range of Kulu Division.

3. *Seedling heights*.—Data were collected for spruce and silver fir in I quality forests in the Parbatti valley, Kulu Division, and the results are as follows :—

Species.	HEIGHT CLASSES.						
	1'-6"	7'-12"	13'-18"	19'-24"	25'-30"	31'-36"	37'-42"
							43'-48"
				Age in years.			
Spruce fir	1	3	4	6	5	6	7
Silver fir	2	5	7	9	10	12	15

4. Conversion factors.—d, g and $\frac{g}{4}$ volume

The following conversion factors for callipered diameter taped girth and $\frac{1}{4}$ girth volume/ πr^2 volume have been worked out for spruce and silver fir from data collected in the Parbatti Range of Kulu Division :—

Species.	d/g.	$\frac{g}{4}$ volume πr^2 volume.	No. of trees.
<i>Picea morinda</i> (spruce)			
	0.3097	0.8297	200
<i>Abies webbiana</i> (silver fir)	0.3005	0.8171	200

5. *Firewood conversion factors*.—A number of firewood conversion factors have also been worked out.

(v) *Miscellaneous.*

Preservation of trees and plots of exceptional interest.—In compliance with Resolution No. 22 of 1929 Silvicultural Conference, Dehra Dun, 30 deodar and 2 *chil* trees of exceptional interest as regards girth, height, age and shape, and 7 plots of virgin silver fir, spruce and *kail* forests, 1 plot of magnificent old *chil* trees, 1 of mature poplar and 1 of virgin scrub forest were preserved for their natural life time. Records on the lines of experimental plots have been prepared for them and a list has been supplied to the Central Silviculturist for record in his office.

Silvicultural Records.—The organisation of the silvicultural records on the same system as the Forest Research Institute was completed and the literature received during the year was marked and lodged filed. There now exist 78 Specific and 155 General Ledger Files on all important species and subjects of interest to the Punjab.

Punjab Forest Library and Periodicals.—The Punjab Forest Library Catalogue with classified index of *Indian Forester*, Volumes I to LVI, arranged on the lines of the Forest Research Institute classification for silvicultural records was issued during the year. All the photographic prints and negatives were classified and an index album was prepared. There are 65 lantern slides depicting erosion in Hoshiarpur and Pabbi forests and various phases of Punjab irrigated plantations for propaganda work.

Staff.—The Research Staff now consists of :—

- One Divisional Forest Officer,
- One Attached Extra Assistant Conservator of Forests,
- Two Forest Rangers,
- Two Foresters,
- Five Forest Guards, and
- Three Clerks.

UNITED PROVINCES.

I.—EXPERIMENTAL SILVICULTURE.

(i) *General.*

The reorganisation of our experimental research was continued on the lines indicated in last year's report, and is now approaching completion. The procedure is now standardised that Divisional Forest Officers carry out stage II investigations and the Silviculturist stage I. The total number of sanctioned silvicultural experiments in the province is 115 i.e., 60 under the Silviculturist, 55 under Divisional Forest

Officers. The chief lines of research remained the same as last year, namely—

- (i) The natural and artificial regeneration of *sal*.
- (ii) Artificial regeneration in general.
- (iii) The economic use of waste lands in the plains districts.

(ii) *Natural Regeneration.*

Sal (Shorea robusta). (a) *From Seed.*—It is now more clearly realised that the problem of natural *sal* regeneration from seed is influenced by a number of different factors and that the study of one factor at a time leads to no conclusive results. The Silviculturist, during the year under report, commenced a series of detailed experiments which when complete may total up to 64 designed to study the various permutations and combinations of the following four main influences :—

- (i) Pure or mixed crops.
- (ii) Heavy and light canopy.
- (iii) Burning.
- (iv) Protection from deer in certain types of *sal* forests.

The fifth important factor appears to be the evergreen weed competition, *e.g.*, in the Haldwani deer proof fences mentioned in last year's report. In other areas again a sixth possible factor is drought, *e.g.*, in Bahraich Division. In North Kheri, Haldwani and Bahraich Divisions, the indications are now fairly well established that game proof fences do not have much influence on stimulating the growth of *sal* seedlings under a heavy canopy and their influence with sufficient light is to stimulate both the *sal* regeneration and to a still greater extent the competing weed growth. Thus we appear to be faced with the dilemma that if we do not fell the overwood the *sal* regeneration does not develop and if we do fell it is liable to be swamped by weeds. An experiment was started last year to find the effect of shrub cutting inside a game proof fence. No conclusion can yet be drawn and this type of experiment will be extended in future. The fact that we cannot at present guarantee successful natural *sal* regeneration from seed when and where we wish is having an important influence on our working plan revision and is the primary reason why recent working plans avoid prescribing regeneration fellings except over fully established regeneration.

Sal (Shorea robusta). (b) *From Coppice.*—Some interesting comparative results have been obtained in the Ramnagar Division on the effects of severe deer browsing on *sal* coppice regeneration. In some compartments a combination of deer browsing with drought and frost

has completely killed the *sal* coppice. In other areas although severe browsing has continued for seven or eight years and the *sal* regeneration appeared moribund, yet it responded immediately to the erection of a game proof fence, so much so that the idea of artificial introduction of teak was considered useless. In other areas again after a certain amount of struggle for one or two years the *sal* coppice managed to grow up into vigorous young sapling crops. These variable results probably indicate that deer are but one of several important adverse factors influencing coppice regeneration in Ramnagar and other Divisions.

Acacia arabica (*babul*).—*From Coppice*.—An experiment has been started and is still in progress in Etawah ravine plantations to see if *babul* (*Acacia arabica*) will successfully coppice. The crop that is being coppiced is 12 to 15 years old and has stopped growth at a diameter of about 6". The coppice so far promises well, the average height having increased from 15" to 57" during the year and practically all the shoots look healthy and are undamaged either by browsing or frost.

Quercus incana (*banj oak*).—*From Coppice*. The Silviculturist is making a detailed investigation on the coppicing power of *banj* oak, which is an important matter in view of the spreading tendency in working plans to manage pure (young) oak crops by clearfelling and (mainly) coppice regeneration. His measurements show a mean height growth of 32" in 2 years, and a stool mortality of about 50 per cent.

Teak (*Tectona grandis*).—Natural regeneration from coppice and seedlings. The ease and certainty of teak natural regeneration almost everywhere in the U. P. (wherever there are trees old enough to produce fertile seed) is a striking and interesting phenomenon in the introduction of this species. A natural regeneration teak sample plot at Ramgarh (Gorakhpur Division) showed the following details :—

Age 8 years.	
Number of stems per acre after thinning	636
Mean height	38 ft.
Mean diameter	4.0"
Volume of smallwood per acre	911 c.ft.
M. A. I. of smallwood	114 c.ft.

(For photographs of this plot before felling, see *Indian Forester*, September 1930, Vol. LVI, plate 35.)

(iii) *Seeds*.

The United Provinces Seed Store at Clutterbuckgunj continued to function as a distributing agency for seeds of all sorts especially teak for the supply of Divisional Forest Officers, whose annual

requirements are ascertained in advance. During the year some 76 maunds of teak seed were supplied on indent within the United Provinces, of which 22½ maunds were Gorakhpur seed and the rest Burma. Considerable quantities of other seeds were supplied to Divisional Forest Officers, zamindars and others interested in forest work.

The entire stock of seed at Clutterbuckgunj except teak (17 tree and 4 grass species) was being tested for viability at the end of the year, under variations of pre-treatment.

(iv) Nursery Work.

There is little to record under this head, the routine raising of stock for field experiments being the chief activity.

(v) Artificial Regeneration.

Artificial regeneration continues to develop in the province so far as financial conditions permit.

I. *Taungya*.—Every effort is being made to extend artificial regeneration by *taungya* plantations. In Gorakhpur Division, the *taungya* has long been established in the Pharenda Range for regeneration of failed *sal* coppice areas, and *taungya* plantations have been or shortly will be extended in most other ranges in this division. Similarly experiments started last year in Gonda Division are sufficiently promising to justify a working plan which will be based largely on *taungya* artificial regeneration both in *sal* and miscellaneous forests. In the Bahraich Division *taungya* is an established success in the Bhinga Range and it is being introduced experimentally in other ranges. *Taungya* is still experimental in the Saharanpur and Ramnagar Divisions and attempts are being made to introduce it experimentally in the Lansdowne, Haldwani and other Divisions. The probability of success combined with the cheapness of the method makes *taungya* very attractive in the present financial crisis.

II. *Departmental Operations*. (a) *Shorea robusta* (*sal*).—Unirrigated line sowings of *sal* at 8' intervals alternating with broadcast sowings of *boga* (*Tephrosia candida*) as a weed suppressor were successful on the rich *bhabar* soil of Lakhanamandi (Haldwani Division), but an early break in the monsoon necessitated resowings of both species and gave the endemic grass and weeds too good a start, so that both *sal* and *boga* required much weeding. Intensive porcupine attack on the *sal* also developed in December and was stopped only by wire netting and a deep ditch.

(b) *Teak*.—The artificial introduction of teak in most areas of the province is now chiefly by root and shoot outtings from nursery plants planted out at the beginning of the rains, the experiment of planting out teak in March having not proved successful on the whole.

(c) *Acacia catechu* (*khair*).—Plantations by sowings with rains weeding and deer proof fences have passed out of the experimental stage in the Haldwani, Ramnagar, and other Divisions. Such work is now prescribed in working plans and removed from the list of divisional experiments. Experiments in propagating this species by cuttings continue, to see whether they are preferable to sowings. Although not absolutely immune from porcupine damage, cuttings seem to be less liable to damage than sowings.

(d) *Dendrocalamus strictus* (*Bamboo*).—As noted in last year's report this bamboo is best propagated by cuttings from two years' old nursery plants, but there is still a good deal of uncertainty as regards areas suitable for its introduction. If introduced into unsuitable localities there is a risk that bamboos will remain whippy and produce comparatively few shoots of commercial value.

(e) *Baib grass*. (*Ischaemum angustifolium*).—Experimental plantations of baib grass (*Ischaemum angustifolium*) have been made in many different divisions under many different conditions and the experiments are now confined to two or three localities. Experience has shown that introduced baib is very liable to be swamped by indigenous grasses especially *kans* (*Sacharum spontaneum*) and requires thorough weeding in the first year or two to become established, and subsequent annual or biennial weeding to prevent the invasion by local grasses. It is not very frost hardy and is susceptible to drought in its early stages. It is liable to damage by deer, pig, porcupine and white ants. Sowings have failed everywhere, while nursery transplants have done somewhat better than forest transplants. By putting on vigorous transplants on well prepared soil and with repeated weedings baib plantations should succeed on a wide range of suitable sites, but it has yet to be discovered whether the cost is economic. Rs. 40 per acre is not an unusual figure for creating without giving very high per cent. of success and not including the recurring cost of subsequent annual weedings. The yield of baib obtained has varied considerably. In one experiment by the Silviculturist in the first year the yield was 4 maunds per acre. In an experiment in South Kheri the yield dropped from 9 maunds per acre in the first year to 3 maunds per acre in the third year owing partly to the area not being weeded. In Gorakhpur the revenue per acre amounted to Rs. 6-4 in 1931-32 and in the Afforestation Division experiments the yield was about 4 maunds per acre. Summing up, we have obtained sufficient information on stage I scale and now we require further infor-

mation as regards costs and financial results on stage II scale. Now experiments on the stage II scale will have to await better financial conditions.

(vi) *Reclamation and Afforestation.*

(a) *Ravine areas of the Etawah District.*—A long series of experiments ranging over the past 15 years has conclusively proved that except for small pockets the extensive areas of ravine lands bordering the Jaman and Chambal rivers are unsuitable for production of timber trees. These experiments have also shown that such areas can produce a little quantity of fuel, and by protection from grazing a very fair crop of fodder grass, also that mere closure to grazing will usually suffice to clothe the ravines with vegetation sufficient to check erosion. As a commercial proposition pure and simple, the afforestation of ravine lands cannot be recommended, but such areas are frequently of local value as fuel and fodder reserves in a precarious tract.

(b) *Usar (Salt Plains).*—The lack of success in the experiments carried out to raise tree crops on *usar* has caused further activities in this direction to cease. On the other hand experiments to grow fodder grass on mild *usar* by the simple expedient of mere closure to grazing are distinctly promising and similar experiments on the worst type of *usar* heavily impregnated with salts are distinctly less promising.

(c) *Bhur (Sandy Plains).*—A small scale experiment in the Budaun District indicates that these barren sandy areas can be afforested by strong cuttings of *khair* and *Dalbergia sissoo*. Sowings of all species and transplants and cuttings of other species have largely failed.

(d) *Fuel Near Door.*—This is a synonym for what was previously called the cow-dung problem. The idea of the experiment is to induce the zamindars or cultivators to grow some tree crops by *taungya* on poor types of soil unfit for permanent cultivation. Unfortunately a start could not be made during the year owing to the difficulty of finding any owner of even the poorest type of soil who was willing to start the experiment. However, it is hoped to make a start during the monsoon of 1932.

(e) *Chandars and Phantas.* (*Grassy blanks usually subject to heavy frosts*).—Two large scale experiments with irrigation from the Sarda Canal were commenced in South Kheri Division in 1928 and in Pilibhit Division in 1929. These have shown that silviculturally it might be possible to reduce frost damage by irrigation to a sufficient extent to enable the *sal* shoots already existing in the *chandars* to grow up. At the same time these experiments have shown that it is administratively almost impossible to obtain sufficient water to keep off the frost since the water supply from the Sarda Canal is not always available, whereas

frost is liable to occur without warning at any time during the three months—December, January, February. It so happened that one or two frost nights have more than once coincided with a period when the Sarda distributary was dry and all the good of previous protection was destroyed in a single night. The cost of irrigation on a large scale also appears prohibitive owing to the extremely sandy soil of these *chandars* which enables the water to percolate away before a sufficiently large area can be irrigated. An experiment in the North Kheri Division of afforestation of grassy *phantas* by deep ploughing with a motor tractor has only proved partially successful. Owing to the need for retrenchment further work of this description has been suspended, but the areas already attempted will be kept under observation.

(xi) *Miscellaneous.*

Burning.—Annual controlled burning of *sal* forests continues to give variable and contradictory results. There now appears little doubt that burning is injurious in the drier types of *sal* forests. In two compartments of North Kheri Division where heavy evergreen invasion is vigorous, and where annual burning has been carried out for a number of years, portions of both compartments have this year been seriously affected by drought, which has resulted in the death of considerable numbers of *sal* trees in the overwood; whether this is coincidence or not, cannot be definitely known. Adjoining areas which have been burnt for one or two years only were very little affected by drought. In the Gorakhpur Division, burning of grasslands seems to indicate that the effect of the burning is to reduce the coarser grasses and to encourage the finer varieties, thereby tending to improve the grazing, but when burning stops the coarser grasses again tend to monopolise the areas.

II.—WORKING PLANS AND STATISTICS.

Yield Tables.

The following permanent sample plots were measured during the year under report :—

Division.	<i>Shorea robusta</i> (Sal).	<i>Terminalia tomentosa</i> (Asan).	<i>Dalbergia sissoo</i> (Shisham).	<i>Cedrus deodara</i> (Deodar).	<i>Pinus excelsa</i> (Kail).	<i>Quercus incana</i> (Pin oak).	Total.
South Kheri .	1	..	1	..	..	..	2
North Kheri .	13	1	..	..	..	..	14
Bahrach .	12	..	..	..	..	..	12
Chakrata .	..	..	..	31	5	..	36
Chakrata Cantt. .	..	..	..	..	..	2	2
Total .	26	1	1	31	5	2	66

The following new sample plot was laid out :—

Division.	<i>Dalbergia sissoo</i> (Shisham).	Total
South Kheri	1	1
Total .	1	1

III.—MISCELLANEOUS.

The sanctioned Research Programme for the 5-year period 1931-1936 was being printed at the close of the year.

No lectures were given during the year.

COORG.

SILVICULTURE.

I.—SANDAL REGENERATION EXPERIMENTS.

North Coorg.

The method of regenerating sandal with a field crop (*ragi*) was continued this year on the same lines as last year, but to a lesser extent as the very low price of *ragi* now makes this unprofitable to cultivate. Sufficient *ragi* was therefore only grown for the feed of the departmental elephants.

Dhall was sown along with sandal and *Erythrina indica* as hosts in all the areas in the Somwarpet Range.

In Aygoor, Kargode and Kattepura only *Lantana* was removed and sandal seeds dibbled 6' × 6' without felling any tree growth with a view to seeing how sandal would thrive under moderate shade. The germination in all the localities was 95 per cent., but subsequently all the seedlings in Kargode and Kattepura died and only 30 to 40 per cent. at Aygoor survived. *Dhall* and *Erythrina* were also dibbled in these areas, but failed except in a few open places. It is useless trying to grow *dhall* under shade.

Experiments with *Cassia siamea* which is reported to render sandal resistant to spike disease were carried out over 4 acres in the 1931 sandal area at Hirikere,

The following areas were taken up in Fraserpet and Somwarpet Ranges :—

Fraserpet Range.

Locality.	Area in acres.	Cost per acre up to end of March 1932.	Total No. of sandal plants surviving at the end of March 1932.	Height of the tallest plant.	Ragi in pallas per acre.	Value of ragi at Rs. 5 per palla.
		Rs.				Rs.
Attur . . .	14	25	5,550	3' 6"	..	..
Meenkolli . .	7	40	2,403	3' 6"	4	22

Remarks.—*Attur.*—*Ragi* was sown by *kurubars* at their own cost and the yield was taken by them. *Dhall* plants are dying but sandal is growing well. The dying of the *dhall* will not matter as hosts are plentiful in this area.

Meenkolli.—*Ragi* was sown departmentally but the harvesting was done by a contractor who took all the yield after giving 30 *pallas* of *ragi* to the Department and this was used for the departmental elephants. *Dhall* plants are not so vigorous as in previous year.

Dibbling Sandal under shade without burning ; Lantana only removed.

In open and exposed places sandal and *Erythrina* were dibbled in alternate stakes, but in the shady areas only sandal and *dhall* were dibbled 6' × 6' with the following results :—

Locality.	Area in acres.	Cost per acre up to end of March 1932.	Total No. of sandal plants surviving at the end of March 1932.	Height of the tallest plant.	REMARKS.
		Rs.			
Dnbare . .	4	43	1,047	0' 4"	Sandal and <i>dhall</i> germinated well but the growth was poor. The surviving sandal plants do not look promising.

Out of 15,600 stakes sown, 9,400 are stocked, the tallest plants varying from 6' to 14' in the different areas.

Somvarpet Range.

The following areas were taken up in 1931 in this Range :—

Locality.	Area in acres.	Cost per acre up to the end of March 1932.	No. of original stakes.	Total No. of sandal plants surviving at the end of March 1932.	Height of the tallest plant.	REMARKS.
		Rs.				
Hudgur . .	12	17	4,800	3,040	2' 8"	No ragi crop was cultivated.
Hirikero . .	16½	24	6,200	4,063	3' 0"	

The following areas were sown with sandal, *dhal* and *Erythrina* under shade (no ragi crop was cultivated) with the following results :—

Locality.	Area in acres.	Cost per acre up to the end of March 1932.	No. of original stakes.	Total No. of sandal plants surviving at the end of March 1932.	Height of the tallest plants.	REMARKS.
		Rs.				
Kargode . .	0½	16	8,100	13	0' 0"	Being a failure it was reburnt and re-sown in April 1932.
Kattopura . .	8	16	110,000	68	0' 10"	
Aygoor . .	6½	29	110,000	1,436	1' 11"	

The results of 1930 *kumri* areas are as follows :—

Locality.	Area in acres.	No. of existing sandal plants in March 1932.	Height of the tallest plant.	Cost per acre during the year.
				Rs.
Kargode	3	21	2' 1"	10
Banawara	3½	176	2' 0"	16
Aygoor	2½	154	5' 0"	17
Hudgur	10½	2,080	6' 10"	8
Hirikero	5½	1,325	5' 4"	8

South Coorg.

Sandal regeneration with a field crop (*ragi*) was continued during the year and the following areas were taken up :—

Locality.	Area in acres.	Cost per acre up to end of March 1932.	Stocking.	Average height.	Tallest plant.
		Rs.			
Ganagur (Tittimatti Range).	10	28*	83	2'	3' 0"
Irumani (Nagerhole Range).	11	21	55	7"	1' 0"

*NOTE.—These costs do not include charges for sowing *ragi* and weeding as these two operations were done by *kurubars*, but the usual rewards will not be paid, as all other operations prior to *ragi* sowing were done departmentally.

It is interesting to note that the Ganagur area is in the midst of dense *Lantana*, while bamboo was prominent in the undergrowth at Irumani.

The operation followed the same lines as indicated in last year's report and the modified espacement of 18' \times 12' was again adopted. 10 to 15 healthy young poles were left on the area as permanent hosts; but unfortunately at Irumani most of them have suffered and many of them have completely died owing to the severity of the burn, due probably to the presence of bamboo in the undergrowth, despite efforts to protect them.

The sandal seed was dibbled in two operations, viz.—

- (a) Untreated seed, dibbled between 11th April 1931 to 14th April 1931.
- (b) Treated seed (i.e., weathered by exposure to sun and wet alternately for 3 weeks) dibbled a month later.

Germination was very satisfactory indeed, being almost 100 per cent. in both places. It was first observed on 18th June 1931.

Lantana and creepers were uprooted as soon as the ground became soft enough. *Erythrina indica* hosts continued to do well from seed. No *Erythrina lithosperma* cuttings were planted.

In the 5-acre patch in the 1930 sandal *kumri* at Ganagur, where *Cassia siamea* was dibbled last year as a host, both by mixing with the sandal seed and at the vacant *Erythrina indica* stakes, no browsing occurred, but the areas where *Erythrina lithosperma* has been planted still continue to attract spotted deer and sambar and occasionally also bison. The sandal in these areas is heavily browsed, which, when combined with bending down and breaking of stems, becomes a serious matter.

As the price of *ragi* remained very low during the year, Rs. 3 to 4 per *palla*, no departmental sowing of *ragi* was done, but local *kurubars* were permitted to cultivate the area and retain the crop. In return they did the necessary weeding and watched the area.

Young plants were protected in the hot weather by grass screens on the western side. No expenditure was incurred on this, the work being done by local Guards.

The following table shows the rate of progress in the development of sandal areas at Ganagur :—

Area.	Percentage of stocking.	Average height.	Height of the tallest plant.
1928 plantation (without <i>kumri</i>) space- mont 6' x 6'.	60	11' 3"	18' 6"
1929 <i>Kumri</i> 12' x 12'	60	6' 6"	13' 9"
1930 " 18' x 12'	50	2' 9"	6' 3"
1931 " 18' x 12'	83	2' 0"	3' 6"

Experiment to observe effect of a light fire on growth of Sandal.

Two experimental plots, each of 2 acres, were laid out in the 1918 Bambookadu plantation (Tittimatti Range), and a light fire was run through one of them in February 1932, the other plot serving as a control plot. The object of the experiment is to observe the effect of scorching on the growth and development of sandal. The trees in both plots were measured and their girths recorded before the scorching was done.

This will be done annually.

Dibbling Sandal under shade.

As an experiment, sandal seed was dibbled in natural forest under light to medium canopy. Strips 3' wide and 10' apart were cleared and staked, the stakes being 5' apart. Sandal and rosewood were dibbled at alternate stakes. Dibbling was done on 30th May 1931, and treated sandal seed was used. Germination of sandal was first noticed on 16th June 1931 and within a few days showed almost 100 per cent. Unfortunately, however, owing to very extensive damage by squirrels and rats, the percentage gradually decreased, until in February 1932 it was found to be 30 per cent. in one plot and 15 per cent. in the other. The rate of growth of the surviving seedlings is very slow, the average height being only 4". The areas of the two plots in question are one and two acres respectively and the cost of the operation worked out to Rs. 6-8-0 per acre.

II.—SPIKE.

Investigation of spike disease on sandal is carried out in conjunction with the Indian Institute of Science, Bangalore, and progress reports are issued by them from time to time.

The development of spike in South Coorg has been under close observation during the year. Three cases were found in the 1918 Bambookadu Sandal Plantation, in the Tittimatti Range, in October 1931.

The infected trees were immediately uprooted and burnt. They were 15", 10" and 7" in girth from the ground respectively and contained no heartwood.

Spike is still prevalent in the 1880-82 sandal plantation at Balumony, Tittimatti Range, having been noticed first in 1914. Up to date 876 trees have been uprooted and only 180 trees remain. The uprooted trees yielded 13 tons of heartwood.

III.—TEAK DEFOLIATION EXPERIMENT.

Observations are still being recorded and reported separately.

IV.—EXPERIMENT TO SEE WHETHER RUBBING OF LICHENS FROM SLOW GROWING AND STAGNATING SANDAL TREES STIMULATES GROWTH.

This experiment is still in progress.

V.—EXPERIMENT TO SEE WHAT EFFECT DIGGING THE SOIL ROUND SANDAL WOULD HAVE ON STAGNATING SANDAL.

This experiment is still in progress.

VI.—EXPERIMENT IN UPROOTING CLIMBERS BELOW GHATS.

Climbers were uprooted in July 1931 for the second time in the 2½ acre experimental plot in the 1930 rosewood area at Makut. The first uprooting was done in October 1930 at a cost of Rs. 5-4-0 per acre. The second uprooting cost only 8 annas per acre. There has been very little regrowth since July 1931.

Similar experiments were continued in Bhagamandla Range. Results so far are strongly in favour of uprooting. In the 1927 plantation at Karike olimbers were therefore uprooted over 60 acres.

VII.—BURNING OF TEAK PLANTATIONS IN THE SECOND YEAR.

The following data have been collected with reference to the part of the 1929 Regeneration Area at Devamachi which was accidentally burnt on 6th March 1930. Mention is made of this area in last year's report:—

Date of enumeration.	AVERAGE HEIGHT.		HEIGHT OF THE TALLEST PLANT.		PERCENTAGE OF STOCKING.	
	Burnt area.	Unburnt area.	Burnt area.	Unburnt area.	Burnt area.	Unburnt area.
4th April 1931 . . .	11' 0"	8' 6"	16' 2"	14' 6"	86	74
15th January 1932 . .	12' 0"	9' 3"	18' 6"	16' 6"	84	74

The following other advantages were observed in the burnt area :-

- (a) More uniformity of growth.
- (b) A much healthier appearance of the seedlings.
- (c) The appearance of other timber species on the area.
- (d) A superior type of undergrowth.
- (e) Cheaper weeding resulting in a saving of Rs. 4 per acre over the whole area for the 2nd year.

Other areas burnt in the 2nd year under control conditions are :-

1931 Deramachi Regeneration Area.—33 acres burnt in February 1932 and 32 acres left as control plot. It is too early to record observations.

1931 Kalthalla Regeneration Area.—Burnt in February 1932, leaving a control plot of 5 acres unburnt. No observations have been recorded yet.

1931 Kumri at Mallipatna.—Of the 6 acres teak, 3 acres were burnt and cut back in February 1932 and 3 acres left as a control plot.

VIII.—EXPERIMENT TO DETERMINE THE BEST METHOD OF ERADICATING REED (*Ochlandra* SPECIES) IN GHAT FORESTS.

Observations have hitherto shown that cutting only, and cutting accompanied by one burning of the cut shoots over the root systems, tends to stimulate growth rather than retard development. Repeated cutting accompanied by burning is now being tried. Reeds were cut for the second time in two one-acre sample plots early in January 1932 and burnt in March. It is too early to record any results.

NORTH-WEST FRONTIER PROVINCE.

I.—EXPERIMENTAL SILVICULTURE.

(i) General.

Mesquite seed (*Prosopis juliflora*) sown last year has proved a failure; this is due to lack of water after germination.

Cryptomeria japonica was sown in nursery beds at 6,000', 7,000' and 8,000' altitude, but the result is poor; very few seedlings have survived.

To protect walnut from rats and monkeys it was sown in wire $\frac{1}{2}$ " mesh netting cylinders 12" long and 4" in diameter with the bottom edge turned out; although all the seed has not yet sprouted, considerable success has been obtained.

Chil seed was sown broadcast following success obtained in previous years.

(ii) *Natural Regeneration.*

An experiment to gauge the correct intensity of blue pine regeneration fellings combined with the presence or absence of grazing was taken in hand in the Siran Division.

Efforts to find out the best method of obtaining blue pine regeneration were continued in the Galis Division. Particular attention was paid to the effect of weeds on young regeneration of blue pine. Three experimental plots for this purpose were laid out and the results obtained by counting the seedlings monthly in these plots show that the mortality is considerably reduced by the weeds which protect them during periods of drought.

(iii) *Seeds.*

The seed year for *chil* was fair, but it was poor for other species (silver fir, deodar and blue pine).

(iv) *Nursery Work.*

Nurseries started in previous years were maintained. One walnut nursery was started in Chatri 3(i) in which 15,000 seeds weighing about 4 maunds have been sown. As the locality is infested with rats the nursery has been protected by sunk wire mesh netting.

3 seers of ash seed has been sown in the nursery in Panjul 3(i) and all of it has germinated.

(v) *Artificial Regeneration.*

The *chil* seed sown broadcast in P. B. I. areas in the Galis Division is doing well. Deodar was sown both in rains and winter in patches and lines and although the germination was fair, the final result was very poor. Blue pine has met with the same fate. Walnut in wire netting cylinders is promising to give fair results. Horse chestnut has proved quite successful wherever sown.

The result of counting mortality percentage of blue pine and deodar natural and artificial is not yet conclusive.

(vi) *Reclamation and Afforestation.*

Some poplar cuttings were planted in slips over a small area.

(vii) *Thinnings and Cleanings.*

These were carried out wherever necessary.

II.—WORKING PLANS AND STATISTICS.

The working plan for Swat Kohistan forests and the revised working plan for the Kagan valley forests are both in the press. The former was brought into force from 1931 and the latter comes into force from 1st April 1932.

CHAPTER III.

UTILISATION AND ECONOMIC RESEARCH.

ASSAM.

EXPERIMENTAL AND COMMERCIAL ACTIVITIES.

(i) *Paper Pulp.*

Owing to trade depression the extraction of *muli* bamboos (*Melocanna bambusoides*) in Cachar by the India Paper Pulp Company was very poor.

In Sylhet the Lawaoherra-Naraincherra Road bamboo *mahal* was sold in auction at Rs. 250 for supplying paper pulp to the Indian Paper Pulp Co., Ltd.

(ii) *Timber Testing.*

Hollock, 5 logs 9' in length, 5 logs 18' in length with five discs 3" thick were despatched from Lakhimpur to the Forest Research Institute for experimental tests, but there was some mistake regarding specimens of *pahari jam* (*Homalinum schlichii*) and *moglai poma* (*Engelhardtia spicata*) from Cachar.

Experiments were made to see whether the Veneer Mills at Murkong Sellek in Sadiya Division could profitably make use of intermediate thinnings from the oldest *hollock* plantations of 1922-23 in Poba Reserve. They were tested on the mill's small lathe which can deal with logs 2' in length and can work them down to a 3" core. The results were very disappointing owing mainly to the presence of borer holes and to hidden knots which only appear after cutting on the lathe, and which invariably developed into definite rot.

(iii) *Wood Preservation.*

Ninetynino *sia nahor* (*Kayca assamica*) M. G. sleepers were sent to the Forest Research Institute for experimental treatment.

Ten M. G. sleepers of each of the following species were also sent for special experiments to collect further data relative to the treatment of the sapwood of the species :—

- | | |
|--------------------------------|---------------------------------------|
| 1. <i>Albizzia lucida</i> . | 3. <i>Dillenia indica</i> . |
| 2. <i>Bischofia javanica</i> . | 4. <i>Dipterocarpus macrocarpus</i> . |

Sleepers of the following species were also sent for experimental test and treatment :—

1. <i>Pterospermum acerifolium</i>	200	4. <i>Sapium baccatum</i>	. 20
2. <i>Anthocephalus cadamba</i>	. 64	5. <i>Kydia calycina</i>	. . 5
3. <i>Elacarpus pilosus</i>	. 20	6. <i>Cinnamomum obtusifolium</i>	. . . 4

Reports have since been received regarding certain of the above as follows :—

Anthocephalus cadamba and *Sapium baccatum* on arrival were found to be unsuitable for the treatment owing to insect attack and it has been decided not to continue further experiment with these species; *Kydia calycina* and *Cinnamomum obtusifolium* have also been condemned on similar grounds. Reports on the remaining species are awaited.

With regard to the experiment of treating 300 softwood poles principally *morhal* (*Vatica lanceaefolia*) in the Naharkatiya plant, although efforts were made to advertise the treated poles for sale both locally amongst the villagers and also by supply to tea gardens, the response was very poor, only a few poles were disposed of during the year.

Arrangements are now being made for the erection of two sample sheds in the Jaipur hat, one of treated and the other of untreated timber, with explanatory notices for the benefit of the public. With trade in its present state and with the economic conditions prevailing at present, little success can be anticipated.

(iv) Timber Seasoning.

The following specimen logs were sent to the Forest Research Institute for experiment in kiln seasoning. The logs were 10 feet in length :—

1. <i>Altingia excelsa</i>	. . 27	3. <i>Castanopsis hystrix</i>	. 21
2. <i>Sterospermum chelonoides</i>	. 20	4. <i>Sapium baccatum</i>	. 22
		5. <i>Duabanga sonneratioides</i>	26

The logs of *Sapium baccatum* on arrival were found to be unsatisfactory for test and the species has been condemned as in the case of its sleepers.

180 tons of logs of *Duabanga sonneratioides* (*ramdalu* or *khokon*) were supplied to the East Indian Railway as a trial order.

(v) Matches.

Two logs of *Trewia nudiflora* sent by the Divisional Forest Officer, Goalpara, to the Assam Match Company at Dhubri for testing their

suitability for match-making have been reported to be good timber for the purpose.

(vi) *Minor Forest Produce.*

An attempt to grow lac on a species of *Debregeasia* and *arhar* (*Cajanus indicus*) failed in the Poba Reserve.

BENGAL.

I.—GENERAL WORK OF ADMINISTRATION.

The Utilisation Officers arranged for the direct supply of standard and special size sleepers to the Eastern Bengal Railway. Sleeper rates fell during the year. B. G. sleepers fell from Rs. 7 to Rs. 6-12 and M. G. from Rs. 2-14 to Rs. 2-12 each.

II.—EXPERIMENTAL AND COMMERCIAL ACTIVITIES.

A start was made in preparing a list of timber species available in merchantable quantities in Bengal, showing the estimated annual output and actual cost, *i.e.*, free of all royalty and profit, per ton of 50 cubic feet sawn, log or square, f.o.r. despatching station, and the name of the station and minimum selling price.

1. *Wood Technology.*—Arrangements were made during the year for the supply of 4 *Betula* logs under Project VIII for testing in peeling, veneering, machine working, etc., to the Forest Research Institute.

Sample planks of *Abies webbiana* (densa), *Acer campbellii*, *Adina cordifolia*, *Cedrela toona*, *Dalbergia sonneratioides*, *Gmelina arborea*, *Hymenodictyon excelsum*, *Michelia excelsa*, *Tsuga brunoniiana* were supplied to Messrs. E. R. Watts & Sons, Ltd., Calcutta, for testing for making Plane Tables. No report as to the results has yet been received.

2. *Timber Seasoning.*—18 teak (*Tectona grandis*) logs have been kept under water in Dhamaigheri and Kaptai streams for seasoning experiments in Chittagong Division in March 1931.

Two wood specimens of hill *kawala* (*Macchilus* spp.) each with botanical specimens (leaves, fruits and flowers) were despatched to the Forest Research Institute on the 12th September for kiln seasoning experiments.

Logs of *Quercus lanellosa* and *Quercus lineata* sent to the Forest Research Institute for testing under Project VII during the year 1929-30 have been stored for test of seasoned specimens.

Sundri (*Heritiera minor*) battens sent to the Government Dockyard at Narayanganj in the year 1929-30, to ascertain if they can be bent for use as the ribs of boats, have proved very successful.

Ten girdled teak trees out of the thinnings in compartments 30 and 31 (Chitmoram) in Sitapahar Range of the Chittagong Hill Tracts Division were reserved for seasoning experiments. They were girdled in March 1932.

3. *Timber Testing*.—Results of tests of the following timber species sent from North Bengal under Projects I and II have been received from the Forest Research Institute during the year.

Pterospermum acerifolium, Willd., sent from Buxa Division, is proved to be a fairly strong wood, suitable for building construction, railway sleepers if treated with preservative, planking and box making. Also suitable for window frames, and doors and door frames in railway carriages.

Quercus lamellosa, Smith, and *Quercus lineata*, Blume, sent from Darjeeling Division, are reported to be strong, tough woods, difficult to season, but if seasoned, suitable for handles, house building, yokes, parts of ploughs and wheels.

Cryptomeria japonica, Dou, sent from Darjeeling Division, has proved an extremely soft light wood specially suitable for making toys and very light boxes and crates.

Schima wallichii, Choisy, sent from Buxa Division, is reported to be strong enough for sleepers and construction work. Also used for planking, dug-outs and plough shears. Suitable for floor boards in railway carriages.

Michelia cathcartii, Hook f. and Th., sent from Kurseong Division, is proved to be a fairly light wood, suitable for planking, boxes, crates, etc., rather soft for sleepers though possible to use under light traffic.

Chickrassia tabularis, Ait. Juss., was sent from Kurseong Division to the Forest Research Institute. The specimens possessing good figure are reported suitable for ornamental work, interior finish, panelling, ornamental furniture and the like. Less ornamental material is strong enough for sleepers, if treated with preservative, and general construction work. Used for beams, scantlings, planking, canoes, also suitable for well construction and coopersage. In railway carriages suitable for floor boards, ceiling boards, roof boards, partition boards, seat and back boards, panelling, decorative work, window frames, doors and door frames.

Streospermum chelonoides, DC., sent from Buxa Division, is reported to be strong enough for sleepers, if treated with preservative, and for general construction. Also used for house building, furniture, boxes, crates, parts of ploughs and yokes.

Duabanga sonneratioides, Ham, sent from Kurseong Division, is reported to be too soft for sleepers, except under light traffic. A light

wood suitable for boxes, packing cases and crates, planking, well construction, troughs, tea boxes, etc. Also suitable for roof boards, partition boards, sents and backs in railway carriages.

Results of tests under Project I of *Quercus lamellosa*, *Quercus lineata* and *Castanopsis hystrix* sent last year to the Forest Research Institute have been received. *Quercus lamellosa* and *Quercus lineata* are strong tough woods, difficult to season, but if seasoned properly they are suitable for handles, house building, yokes, parts of ploughs and wheels.

Castanopsis hystrix is strong enough for sleepers, if treated with preservative, suitable for planking, posts, yokes and parts of ploughs.

The results of the 3 *champs* (*Michelia* species) tested in green condition at the Forest Research Institute have been received. From the observations on the green tests and the general appearance and structure of the timber it appears that *Michelia montana* is suitable for any purpose for which *Michelia champaca* might be used. *Michelia oblonga* is distinctly a lighter, softer and weaker wood than the other two and would be suitable for packing cases, crates, drawer bottoms, backing, toys and other uses for which a light and relatively weak wood is suitable.

The Timber Adviser to the High Commissioner for India suggested our sending 100 cubic feet of *toon* planks to London for display at the Building Exhibition next September by a firm. Arrangements have been made accordingly for despatch.

Arrangements for testing logs of *Alnus nepalensis* under Project I were made during the year.

4. *Wood Preservation*.—Details of the treatment given to the 200 *buk* (*Quercus lamellosa*) and *phalat* (*Quercus lineata*) sleepers supplied to the Darjeeling-Himalayan Railway, for trial in their line, were received during the year. As a result of the treatment in hot oil in an open tank for about 12 hours there was an apparent penetration of $\frac{1}{4}$ inch to $\frac{1}{2}$ inch. The sleepers have been in the track for nearly a year and show no signs of deterioration.

200 M. G. sleepers of *Acrocarpus fraxinifolius* were despatched from Kalimpong Division during the year to the Forest Research Institute for testing in the line under Project IV.

5. *Minor Products*.—At the request of the Principal, Plant and Animal Products Department, Imperial Institute, London, a flowering specimen of *Sambucus javanica* was sent from Darjeeling Division. The specimen was submitted to the Director of the Royal Botanic Gardens, Kew, who reports "it is undoubtedly *Sambucus hookeri*, Rehder, a native of Sikkim and possibly also of Upper Burma".

Report on the samples of pith of the above species which were also sent to the Principal, Plant and Animal Products Department, Imperial

Institute, London, for test as a polishing material for optical glasses, has been received during the year. They were submitted to the Director of British Scientific Instrument Research Association, London. He states that trials have shown that the pith is of little use for the purpose in view, being too crumbly, and that consequently supplies would not be of interest to the optical trade.

With a view to find out if it is profitable to tap *gurjan* (*Dipterocarpus* species) and to ascertain its effect on the quality of its timber a small experiment was started at Bhomariaghona in the Cox's Bazar Division. On the average 2½ sacs of oil were obtained per tree for the period 1st February to 31st March. A sample of the oil was sent to a Calcutta paint manufacturing firm for testing its uses, if any, in paints, during the year.

A report showing the percentage increase or decrease in strength of tapped *Dipterocarpus turbinatus*, Gaertn. *D. costatus*, Gaertn. and *D. alatus*, Roxb., supplied from Cox's Bazar Division to the Forest Research Institute, as compared with untapped controls of the same species was received. From these results it appears that the tapped specimens of *Dipterocarpus turbinatus* were somewhat heavier and shrank somewhat more than the untapped controls. Their strength as a beam was from 4 to 12 per cent. less than the latter, while their compressive strength across the grain, hardness, and resistance to shear and tension were from 5 to 16 per cent. above the untapped material.

The Forest Research Institute report "in all respects *Dipterocarpus costatus* from the tapped trees gave values from 1 per cent. to 12 per cent. lower than from the untapped trees, except that the tapped material was slightly stronger in resistance to shear".

"The tapped material of *Dipterocarpus alatus*, on the other hand, varied from 2 per cent. to 11 per cent. above the untapped material except in crushing strength along the grain, and hardness, and resistance to splitting in which the tapped material fell slightly below the untapped."

The report adds that considering all the values together, *D. turbinatus* shows no pronounced tendency either towards decrease or increase of strength as the result of tapping. *D. costatus* shows slight tendency towards decrease of strength and *D. alatus* shows a slight tendency towards increase of strength. All these variations, however, are well within the range of what may be expected in any species of wood, and the net result of the whole series of tests is a strong indication that for practical purposes, no consistent material strength difference resulted from the tapping of the specimens tested and that in ordinary use, it is unnecessary to make any distinction between timber obtained from tapped and untapped trees of these species.

6. *Siliguri Sawmill*.—The mill dealt with 96,000 cubic feet of timber at a cost of 4·3 annas per cubic foot direct charges and 10·76 annas including depreciation, interest and overhead charges. Including interest there was a loss of Rs. 1,000, but excluding it there was a profit of Rs. 6,000.

The average wastage in converting round timber was 44·5 per cent., including slabs, and the wastage in reconverting sawn timber was 17·7 per cent.

It may be noted that while the sale of round *sal* timber went down from 21,077 cubic feet to 20,789 cubic feet on account of the trade depression continuing throughout the year under report, that of the sawn *sal* increased by about 8,000 cubic feet and that, in spite of considerable reductions in the sale prices, the gross revenue collected on mill account increased by nearly Rs. 11,000. This is indeed very hopeful.

It may also be noted that while the average return from sale of good selected *sal* logs was only Re. 1 per cubic foot that from sale of sawn *sal* (manufactured almost entirely from defective logs which are ordinarily unsaleable as such) in terms of round timber amounted to Rs. 1·22 per cubic foot or nearly 4 annas more than the former. This alone justifies the existence of the mill. Then again by taking away more than 93,000 cubic feet of bad *sal* logs annually from the log-market, the mill is certainly helping a lot towards keeping up the prices of *sal* logs.

Though the gross revenue, as stated above, registers a fair increase, the trading account shows a loss of Rs. 982 as a result of the year's work. This loss is more apparent than real and is due to :—

- (1) the stock being written down to a considerable extent, and
- (2) the cost of defective and unsaleable logs supplied to the mill, being valued at the highest market rates for good selected timber.

In view of the fact that the mill is supplied with only unsound, defective and ordinarily unsaleable logs, it is hardly justifiable to charge for them at the highest market rates for good and sound timber. Perhaps it would be more equitable to charge for the logs at cost of carting plus a royalty of two annas per cubic foot.

Adoption of the forms proposed by the Director of Commercial Audit to the Accountant General, Bengal, for maintaining the *pro forma* accounts, has led to slight changes in the method, so far followed, of analysis of expenditure and to a correction of the Capital and Interest accounts. Otherwise the accounts were found to have been maintained since the year 1927-28 on sound commercial lines. The mill-accounts may now be said to have been brought to a strictly commercial basis.

7. The usual liaison was maintained with the Forest Research Institute. There was also co-operation with the Timber Advisory Officer, Railway Board, India, and the Timber Adviser to the High Commissioner, India House, London.

BIHAR AND ORISSA.

EXPERIMENTAL AND COMMERCIAL ACTIVITIES.

The seasoned timbers disposed of last year were utilised for cabinets in the Forest Office and in making furniture by private individuals. They have all given satisfactory results.

Rosha grass (*Cymbopogon martini*).—2 maunds and 26 seers of freshly cut *roska* grass were sent to the Forest Research Institute. The oil content of this grass was found to be very low. Further, as the grass does not grow in this province to an extent to get any firm interested in its commercial extraction, the question of its commercial extraction had to be abandoned.

Holicletes isora.—Extraction of *Holicletes isora* fibres was stopped for want of demand.

Lac.—The lac market is at present very depressed and owing to the need for economy, most work in connection with the lac orchards, so long maintained by the Department, has been suspended indefinitely. The Palwal Lac Orchard is, however, maintained under the supervision of the Forest Research Officer in co-operation with the Palwal Co-operative Society. Kundri Lac Orchard in the Palaman Division having passed the experimental stage is now being managed under a more intensive scheme of control.

Sabai grass (*Pollinidium Ischaemum angustifolium*).—A special survey was carried out by Mr. J. W. Nicholson, Deputy Conservator of Forests, under the orders of the Local Government to investigate the question of the big decline which has taken place during recent years in the output of *sabai* grass from the Palharin Hills in the District of Santal Parganas. This decline is ascribed to the neglect of cultural operations, mainly weeding. The cost of rehabilitating the industry is estimated at Rs. 2,00,000. The total areas of all the *sabai* bars were estimated at 38,000 bighas.

The *sabai* plantation experiment in the Kollan Division was continued, but as the natural supply in the division is not at present exploited to the full, the question of its cultivation has been abandoned.

BOMBAY.

EXPERIMENTAL AND COMMERCIAL ACTIVITIES.

The sample consignments of tonk and laurel, referred to in last year's report, sent to South Africa did not result in any further business with

Messrs. Rhodesian Timbers, Ltd., owing chiefly to excessive freight charges. During the year a sample consignment of 10 tons of sawn teak in assorted sizes was despatched to Messrs. Mallinson & Sons, London.

Lac.

Experiments were continued in the Dharwar and Hangal-Dhundshi Ranges of the Dharwar-Bijapur Division, but the experiment in the latter Range had to be discontinued owing to the failure of the lac insect to thrive. In Dharwar Range the experiment will be continued for another year.

In the North Khandesh and Surat Divisions, some *ber* (*Zizyphus jujuba*) and *galas* (*Butea frondosa*) trees were infected with brood lac, obtained locally, with some degree of success. The result obtained in North Khandesh on *ber* trees has been encouraging and the best so far obtained.

In the Paneh Mahals Division, experiments were carried out in the Godhra and Halol Ranges. In the former Range the crop was maintained, whereas in the latter the experiment had to be given up owing to very poor results.

BURMA.

I.—GENERAL.

Since October 1931 the Forest Botanist and Lecturer in Botany in Rangoon University has held charge of the post of Forest Economist, but the time he could give to the duties was naturally limited.

II.—EXPERIMENTAL ACTIVITIES.

(i) *Summary.*

The chief activities during the year under report are summarised below, the details being dealt with later in the sub-sections concerned :—

- (a) Placing orders for the supply of 120 tons of various species of hardwood squares required by the Timber Research Division for experimental purposes and public sale.
- (b) Passing and arranging for shipment of about 850 tons of logs and squares of various hardwoods for the East Indian Railway, Calcutta.
- (c) Arranging to supply and passing of 1,000 *padauk* (*Picrocarpus macrocarpus*) test sleepers for the Burma Railways.

- (d) Passing and certifying various small lots of *pyingudo* (*Xylia dolabriformis*) squares under shipment to Karachi by Messrs. Steel Bros. and Co., Ltd., Rangoon.
- (e) Examination of and report on teredo damage to test-blocks of various timbers put down in Rangoon harbour by the Admiralty.
- (f) Answering miscellaneous inquiries as to timbers, bamboos, lac, cutch, *tuba* root (*Derris elliptica*) and other minor forest produce.

Only 14 days were spent on tour during the year.

(ii) Details of Activities.

1. Wood Technology.

During the year 153 timber specimen billets were sent in by the Forest Botanist and his staff: from them 832 standard blocks were cut and added to the Burma collection in the Offices of the Conservator of Forests, Utilization Circle, and the Forest Botanist. Duplicates were distributed to Dehra Dun, Oxford, Kew, etc.

At the request of Professor H. P. Brown of Syracuse and of the Wood Technologist, Forest Research Institute, Dehra Dun, spare blocks of *Dipterocarpus* species were sent to them for research purposes.

Routine identifications were carried out for the Timber Research Division and numerous requests for identifications from firms and Divisional Forest Officers were also dealt with. The help of the Forest Research Institute, in doubtful cases, is gratefully acknowledged.

A case of substitution of *thitka* (*Pentace burmanica*) for *thitkado* (*Cedrela toona*) in a lot of timber sent to the Ishapore Rifle Factory was detected.

2. Timber Seasoning.

As a measure of economy it was decided to close the kilns in the Timber Seasoning Section of the Timber Research Division as soon as sufficient stock of timber for use in the workshop had been accumulated but big furniture orders and a demand for large quantities of seasoned *mau* (*Anthocephalus cadamba*) timber for box-shooks necessitated their being kept in operation nearly all the year. The amount of timber seasoned actually increased from 135 tons in 1930-31 to 228 tons, which cost on an average Rs. 2-9-10 per cubic foot, the lowest figure so far achieved. The reduction is largely accounted for by the fact that over half the output consisted of *mau*, this timber seasoning comparatively

quickly. The average time required in the Tiemann kilns was in fact only 10 days and the schedule would have been even shorter had there not been a lag of five days in the drying on the "leaving air" side of kilns of this type. Runs in the 75 cubic feet internal fan kiln averaged only 8 days and it is thought that the species might easily stand more rigorous conditions of seasoning which would reduce the time still further.

Savings in running costs were also effected by reduction of staff. Species seasoned for the first time were *mau*, *didu* (*Bombax insigne*), *lelpan* (*Bombax malabaricum*), *baing* (*Tetrambles nudiflora*) and *kuthan* (*Hymenodictyon excelsum*), all except *mau* being lumped together in one run of the 75 cubic feet fan kiln. Satisfactory results were obtained for all the species. The application of very severe treatment to *taung thayet* (*Swintonia floribunda*) was unsatisfactory and it is recommended that the conditions used in 1930-31 be adopted for future runs.

An improved technique for the seasoning of *taukkyan* (*Terminalia tomentosa*), worked out last year and involving frequent steaming treatments during the run, met with marked success and timber seasoned by the new method gave very satisfactory results when made up into furniture.

An interesting experiment carried out in the 5 cubic feet internal fan kiln revealed that the optimum moisture content of *mau* for box-shooks is 12-15 per cent., drying below that figure leading to defects in the manufactured article.

Large quantities of *mau* timber were air-seasoned towards the close of the year and the results appear most satisfactory.

3. Timber Testing.

Owing to shortage of funds no logs were sent to the Forest Research Institute for test. The programme has now fallen somewhat into arrears, as it had been arranged to supply—

Sterculia campanulata for Project I (Systematic strength tests on small clear specimens).

Bombax malabaricum for Project I (Systematic strength tests on small clear specimens).

Dalbergia cultrata for Project I (Systematic strength tests on small clear specimens).

Millettia pendula for Project I (Systematic strength tests on small clear specimens).

Carallia lucida for Project I (Systematic strength tests on small clear specimens).

Dalbergia oliveri for Project I (Systematic strength tests on small clear specimens).

Bombax insignis for Project I (Systematic strength tests on small clear specimens).

Anthocephalus cadamba for Project I (Systematic strength tests on small clear specimens).

Terminalia tomentosa for Projects I and II (Tests in structural sizes), and also genuine *Dipterocarpus pilosus* for check experiments on the results from some doubtful material.

Further, arrangements were made to send logs of—

taungthayet (*Swintonia floribunda*),

kaungghmu (*Anisoptera glabra*),

thingadu (*Parashorea stellata*),

for Project VIII (Veneers), but it was not found possible to collect them till after the close of the year under report.

4. Wood Preservation.

The investigation of resistance to teredo in the Rangoon River was concluded during the year and the results collected in Burma Forest Bulletin No. 28, which is summarised below. It was concluded that creosoted *kanyin* (*Dipterocarpus* spp.) was the most suitable wood for marine piling and fenders in Rangoon harbour. Burma teak and British Guiana greenheart offer about equal resistance to the Rangoon teredo (*Xylotrya*). Whether creosoted or not both are inferior to creosoted *kanyin* for use at Rangoon.

Complaints of mould on match splints of *Sterculia campanulata* (*saw-bya*) during the monsoon were investigated and the fungus identified by the Mycologist, Agricultural College, Mandalay, whose help is gratefully acknowledged, as *Aspergillus fumigatus* (*Fernsius*). The treatment suggested was the steeping of the splints in 2 per cent. zinc sulphate solution during manufacture but the match factory preferred to try formalin and 0.2 per cent. solution of mercuric chloride. Formalin proved too volatile and the results with mercuric chloride are not yet definitely successful.

5. Minor Forest Produce.

There were numerous inquiries for Minor Forest Produce. Samples of cutch in various forms, e.g., basket, tablet, "krystal", etc., were analysed at the Rangoon University and interim results communicated to the Forest Research Institute and to Messrs. J. J. Barraclough, Rice and Trading Co., Ltd., at whose instigation the investigation was taken up. The research has not been completed. Samples of tuba root (*Derris elliptica*) have been sent to the Imperial Institute, London, for toxicity

tests at the Rothamsted Experimental Station, Herts. It is estimated roughly that about 20,000 lbs. of dried root will be available annually from Burma for export. If the cost of collection can be kept down there is hope of the Burma *tuba* root finding a market in England in competition with Sumatran and Malayan roots. A sample of the bark of *Edgeworthia gardneri* was obtained from the Kachin hills of Myitkyina District in response to a request from the Director-General of Commercial Intelligence and Statistics, Calcutta. The plant is said to be very abundant in certain areas of the Sadon sub-division.

An inquiry was received from New Zealand for bamboos for the walls of cheese crates. Sample battens of *kyathaungwa* (*Bambusa polymorpha*) and *wabo* (*Dendrocalamus brandisii*) were sent to the enquirer. *Kayinwa* (*Melocanna bambusoides*) bamboo samples from Bassein were sent to two firms in England for trial as umbrella handles. One of the firms sent a fairly favourable report on the samples but no business has yet resulted.

There were numerous inquiries for *myinwa* (*Dendrocalamus strictus*) to make fishing rods.

Samples (full bamboos cut into sections) of *wathabut* (*Teinostachyum helferi*), *wanwe* (*Dinochloa m'clellandi*), *kyatwa* (*Cephalostachyum* sp.), *tabindaing* (*Bambusa burmanica*), *kamyin* and *katharing* were sent to the Forest Research Institute as exhibits for the museum. Samples of *tiyowa* (*Thyrsostachys siamensis*), *myinwa* (*Dendrocalamus strictus*), *waya* (*Oxytenanthera nigrociliata*) and *kayinwa* (*Melocanna bambusoides*) bamboos (full lengths cut into sections) were also sent to the Liverpool Museum. Samples of various bamboos, cutch in various forms, *sakan cane*, rosins, *kanyin* oil, etc., were sent to the High Commissioner for India, London, as exhibits in the Commercial Show-Room at the India House.

Mrs. Dorothy Norris, Director of the Lac Research Institute, Ranohi, toured in Burma and the Federated Shan States during the year. The sliding scale of export duties on lac, referred to in last year's report, has worked satisfactorily.

6. Paper Pulp.

In Tavoy and Mergui Divisions experiments to show the best systems of cutting *waya* (*Oxytenanthera nigrociliata*) and to determine its re-growth were initiated. The methods of felling adopted were :—

I. Felling of whole clumps.

(a) Under a clear-felling system.

(b) Under a clump-selection system, leaving not less than two untouched clumps between successive clear-felled clumps.

II. Felling by whole clumps except the unripe culms in each clump.

(a) Under a clear-felling system.

(b) Under a clump-selection system as described in I (b) above.

III. Felling of half-clumps only, leaving unripe culms in the untouched half for preference.

IV. Felling of quarter clumps only, again leaving unripe culms as in III above.

The plots were fire-protected and their condition after felling recorded at intervals. Fellings were done by each method at the beginning, middle and end of the rains.

The results obtained were, briefly :—

- (1) Re-growth after clear felling (method I a) is weak and a number of clumps are killed, though at the end of the second rains after felling it appears that some plots had made good progress towards recovery.
- (2) There are also signs of deterioration in crops treated by methods I b, II a and II b.
- (3) Felling by half-clumps seems a good method of reaping a good yield per acre without injuring the growing stock.
- (4) Re-growth is best when felling takes place early in the rains.

The sample plots will be kept under further observation.

It was found by experiment that green *waya* lost moisture to the extent of 35-45 per cent. of its weight when air-dried.

7. *Tans.*

Nil.

8. *Wood Working.*

The details of the work under this head are given in the Annual Report of the Timber Research Division. Only the broader aspects are discussed here.

The sawmill ran for only five months of the year, but the frame saw was transferred to the Workshop and used there in the conversion of slitches. The average recovery of converted timber in the sawmill was 53 per cent. as compared with 60 per cent. last year.

The workshop handled 34 timbers, which are listed below in descending order of importance :—

Constructional.	Industrial.	Furniture.
MAJOR ATTENTION.		
1. <i>thingan</i> = <i>Hopea odorata</i> .	1. <i>mau-lettan-she</i> = <i>Anthocephalus cadamba</i> .	1. <i>yinma</i> = <i>Ohukrasia tabularis</i> .
	2. <i>yon</i> = <i>Anogeissus acuminata</i> .	2. <i>padauk</i> = <i>Pterocarpus macrocarpus</i> .
	3. <i>panga</i> = <i>Terminalia chebula</i> .	3. <i>taukkyan</i> = <i>Terminalia tomentosa</i> .
	4. <i>taungthayei</i> = <i>Swintonia floribunda</i> .	4. <i>sit</i> = <i>Albizia procera</i> .
	5. <i>thitkado</i> = <i>Cedrela toona</i> .	5. <i>kyana</i> = <i>Carapa moluccensis</i> .
	6. <i>binga</i> = <i>Mitragyna diversifolia</i> .	6. <i>aukchinza-ni</i> = <i>Amoora wallichii</i> .
	7. <i>hmanthin</i> = <i>Cinnamomum</i> sp.	7. <i>thitka</i> = <i>Pentace burmanica</i> .
	8. <i>hnaw</i> = <i>Adina cordifolia</i> .	8. <i>sandawa</i> = <i>Cordia fragrantissima</i> .
	9. <i>karawe</i> = <i>Cinnamomum inunctum</i> .	9. <i>thinwin</i> = <i>Milletia pendula</i> .
	10. <i>thitmin</i> = <i>Podocarpus neriifolia</i> .	10. <i>tamalan</i> = <i>Dalbergia oliveri</i> .
	11. <i>sagawa</i> = <i>Michelia champaca</i> .	11. <i>chay</i> = <i>Gluta tavoyana</i> .
	12. <i>yemane</i> = <i>Gmelina arborea</i> .	12. <i>oak</i> = <i>Quercus serrata</i> .
	13. <i>kanzo</i> = <i>Tarrietia javanica</i> .	13. <i>manivaega</i> = <i>Carallia lucida</i> .
	14. <i>ananma</i> = <i>Fagraea fragrans</i> .	
	15. <i>kaungmu</i> = <i>Anisoptera glabra</i> .	
	16. <i>te</i> = <i>Diospyros burmanica</i> .	
	17. <i>tharapi</i> = <i>Calophyllum inophyllum</i> .	
MINOR ATTENTION.		
2. <i>pyinma</i> = <i>Lagerstræmia flor-egina</i> .		
3. <i>in</i> = <i>Dipterocarpus tuberculatus</i> .		
4. <i>toak</i> = <i>Tectona grandis</i> .		

The most important furniture timbers were *taukkyan*, *yinma*, *padauk*, *aukchinza-ni*, *kyana*, *sit*, *thingan* and *thitka*. Large quantities of *yinma* were supplied for panelling, ceilings, etc., in important buildings in Rangoon. Floor-blocks of *taukkyan* and *padauk* were also in demand.

There was a slight increase in the sales of kiln-seasoned *binga* and *hnaw* for the making of printing blocks and *yemane* was also used for this purpose.

The samples of *te* (*Diospyros burmanica*), referred to in last year's report, were considered unsuitable for golf-club heads by the professionals to whom the samples were submitted. This species is also under test

for the same purpose by a Calcutta firm. Half-wrought heads of *kyana* (*Carapa malaccensis*) have been sent to Australia for experiment.

A set of samples of the 27 timbers which forms the subject of Burma Forest Bulletin No. 22 were sent to the Timber Adviser to the High Commissioner for India, London, to the Liverpool Museum, and to the Australian Council for Scientific and Industrial Research. Owing to the slackness of trade there was a considerable fall in the demand for hammer and other tool handles.

The workshop waste rose from 36 per cent. to 45 per cent. during the year, an increase due to the fact that defective timber, etc., could not be cut off before seasoning owing to the closure of the sawmill. Workshop sales amounted to Rs. 1,03,400 of which 46 per cent. was to Government (including Rangoon University) and 54 per cent. to the public. The total value of last year's sales was Rs. 1,01,000.

Extensive developments took place in connection with the substitution by Burmese species of imported Japanese timber for boxes and crates. At first the *taungthayel* (*Swintonia floribunda*), referred to in last year's report, was accepted and a trial order for 200 boxes received and fulfilled. At the same time experiments were made with *mau-lettan-she* (*Anthocephalus cadamba*), which was found to possess practically the same virtues as *taungthayel* as to strength and ability to hold a nail, and to have the additional advantages of being both lighter and a better colour. It was thought by the Burmah Oil Company to be preferable to *taungthayel* and 5,500 boxes of various sizes were supplied to them in *mau* timber.

As the supplies of *mau-lettan-she* are not considered sufficient to meet the full demand in normal times, experiments with other timbers likely to prove efficient substitutes, e.g.,

letpan=*Bombax malabaricum*,

didu=*Bombax insignis*,

kuthan=*Hymenodictyon excelsum*,

have been put in hand.

9. Miscellaneous.

(1) *Efforts to increase the sales of Burma timbers other than teak.*—Only 10 tons of first-grade unwrought converted timbers were sold by the Timber Research Division during 1931-32, but the order referred to in last year's report, viz., the supply of 850 tons of Burmese timbers other than teak to the East Indian Railway, Calcutta, was fulfilled during the year. The Conservator of Forests, Utilization Circle, and the Divisional Forest Officer, Timber Research Division, acted as intermedi-

aries and shipping agents to the numerous Burmese traders among whom the order was distributed.

It appears that extensive use of *taungthayet* (*Swintonia floribunda*) for box shooks is not immediately probable, as *mau-letlan-she* (*Anthrocephalus cadamba*) is preferred in the market now open.

In order to give *padauk* (*Pterocarpus macrocarpus*) a fair trial, 1,000 sleepers were purchased on behalf of the Burma Railways and carefully passed. They were placed in the road near Rangoon where they will be kept under observation.

With the object of providing employment in Burma and reducing the imports of coal, an effort was made to induce the Burma Railways to revert to the use of wood-fuel in their engines in certain districts. The Railway reported that their present engines were unfitted for burning wood and that a return to its use as fuel would interfere seriously with their efficiency.

An attempt to find a market in England for *aukchinza-ni* (*Amoora wallichii*) which is available in large quantities in Upper Burma, and which could be marketed as *Amoru mahogany*, was frustrated by the general trade slump.

Sampan wood to the amount of 300-400 tons (converted) per annum is ordinarily imported into Burma from Penang and Singapore. It consists of soft wooded species of *Shorea*. It sold at Rs. 270 to Rs. 340 per ton in Rangoon in 1925 but the slump in the paddy trade has brought the price down to Rs. 40 to Rs. 50 per ton at present, and though it has been found that *Shorea assamica* (*kyilan*) which occurs to a limited extent in Myitkyina and Katha and from which a satisfactory sampan has been made, is a suitable substitute, the current demand for sampan wood is too small to justify further investigation immediately.

Investigations of new matchwood species were carried out by Messrs. Adamjee Hajee Dawood and Co., Ltd., with material provided by the Timber Research Division. The results were as follows:—

Found unsuitable.

- (1) *aukchinza* (*Diospyros ehretioides*)
- (2) *thitsein* (*Terminalia belerica*)
- (3) *myaukchaw* (*Homalium tomentosum*)
- (4) *myaukngo* (*Duabanga sonneratioides*).

Found possible but of inferior value.

- (5) *tawthayet* (*Mangifera* sp., possibly *indica*). Tests of *taungthayet* (*Swintonia floribunda*), *thilpok* or *baing* (*Tetrameles nudiflora*) and *kaungghmu* (*Anisoptera glabra*) remain to be carried out.

(2) *Comparative counts of "Bee Holes" made by the moth Xyleutes (Duomitus) ceramius in teak from various localities.*—The work, referred to in last year's report, was completed and the results of the whole investigation collected in a bulletin, which was not, however, published during the year. The research involved "the examination as converted timber of 484 teak trees from 16 localities in the Pegu Yomas with an average annual rainfall ranging from 47 to 102 inches. All the localities sampled were less than 500 feet above sea-level". The conclusions reached by Mr. C. W. Scott were:—

"As regards beeholing the average annual rainfall is of dominant importance in both natural and plantation teak forests. Usually the higher the rainfall the worse the beehole damage." Above 1,500 feet above M. S. L. the beehole may be bad, although the rainfall is low, but most of the main teak forests of Burma lie below 1,500 feet.

"The available data suggest that an average annual rainfall of 60 inches is about the maximum for localities below 1,500 feet where beeholing may be expected to be definitely light. It is not yet known how, apart from rainfall, such factors as steepness of slope, dryness of forest type and intensity of annual burning affect beeholing. It seems probable that the drier the forest the less the beehole. Plantation teak is much more beeholed than natural teak from the same locality, even if the latter adjoins the plantations closely. If teak plantations are made in localities with over 60 inches of average rainfall the great bulk of their timber is likely to be of reduced value owing to beehole.

There is some evidence, which requires further study, that beeholing increases in a tree upwards from ground level and inwards from the bark towards the pith. It is probable that the greater the girth of a tree the greater the proportion of clean timber it is likely to yield in any given locality."

(3) *Experiments on the specific resistance to teredo attack of various Burma timbers.*—Burma Forest Bulletin No. 28, entitled "Tests in the Rangoon River on the damage by Marine Borers to various woods including Burma teak and British Guiana greenheart, creosoted and untreated", describes the experiments carried out in this direction during the past few years and states the conclusions reached. It was found that of 17 different Burma woods other than teak, tested untreated, only one, *thande* (*Sterospermum* sp.), resisted the Rangoon teredo better than teak. Creosoting in an open tank was found to increase very greatly the resistance of the woods tested, the best results being shown by creosoted *kanyin* (*Dipterocarpus* spp.). Dilution of the creosote with earth oil reduced the protective effect, but up to 50 per cent. dilution the reduction was not extremely marked. There is but little differ-

ence between Burma teak and British Guiana greenheart in their resistance to the Rangoon teredo. Creosoting increases the resistance of both woods about equally. For harbour work at Rangoon both teak and greenheart, whether creosoted or not, are much inferior to creosoted *kanyin*. In fresh water or the higher parts of a wharf which are not submerged in salt water the merits of *pyingado* (*Xylia dolabriformis*), which is much harder and stronger than *kanyin*, deserve consideration. Wherever tested, except in tropical salt waters, *pyingado* has proved extremely durable. Out of salt water, untreated *pyingado* would far surpass treated *kanyin*.

Caution is advisable in applying the Rangoon results elsewhere, because the intensity of teredo attack and the species involved vary greatly in different parts of the world. Local tests are advisable.

Test blocks put down by the Admiralty in 1930 were cut up and examined during the year. The only species which proved resistant untreated was *billian*, a timber derived, it is thought, from Borneo. Further details of this timber are being sought. When creosoted all the species tried, viz., *balaw* (from Singapore), turpentine (*Syncarpia laurifolia*) (Australian), *billian*, greenheart, teak and *pyingado* (*Xylia dolabriformis*), were resistant. Untreated turpentine was moderately resistant.

(4) *Timber Passing*.—The timber for the East Indian Railways and 1,000 test sleepers of *padauk* (*Pterocarpus mucrocarpus*) for the Burma Railways were passed during the year (see last year's report). At the request of Messrs. Steel Bros. and Co., Ltd., Rangoon, a few small lots of *pyingado* (*Xylia dolabriformis*) squares were also certified and passed.

(5) *Enquiries and Liaison*.—The usual number of miscellaneous enquiries were dealt with. The usual liaison was maintained with other specialists in Burma and with the Forest Research Institute. There was also co-operation with the Timber Advisory Officer, Railway Board, India, the Forest Products Research Laboratory, Princes Risborough, Bucks, England, the Imperial Institute, London, the Committee of the Institution of Civil Engineers on Deterioration of Structures Exposed to Sea-action and the Timber Adviser to the High Commissioner, India House, London.

CENTRAL PROVINCES AND BERAR.

I.—EXPERIMENTAL AND TRADE ACTIVITIES.

(a) *Experimental*.—Nil.

(b) *Minor produce*. *Lac*.—The enormous damage done to lac brood by the severe heat in May and June 1931 throughout the province is

reflected by drops in yield which was as follows :—

Division.	LAC COLLECTED.						REMARKS.
	1931-32.			1930-31.			
	Md.	Sr.	Ch.	Md.	Sr.	Ch.	
Bhandara	50	18	0	550	15	0	
Bilaspur	18	21	13	74	31	12	
Damoh	537	0	0	3,059	0	0	
Chhindwara	12	37	0	37	16	0	
Jubbulpore	27	36	0	172	31	0	
Seoni	85	0	0	236	0	0	
Amraoti . . . . .	..	..	..	1	36	0	
Melghat . . . . .	..	..	..	6	7	0	
South Raipur	470	0	0	500	0	0	
North Chanda	0	13	0	10	30	0	
Saugor	48	0	0	611	14	8	
Hoshangabad	11	0	0	91	0	0	
TOTAL	1,267	8	13	5,381	23	4	

On top of this the T. N. Rate fell from Rs. 29 to Rs. 20, and the revenue from Rs. 86,141 to Rs. 16,722, which left a very narrow margin of profit.

Harra (Myrabolams).—The crop was a poor one ; reported to have been only 0-8-0 in the rupee.

The fall in prices left a bare margin of profit, and departmental collection in Balaghat was given up and the crop sold on a three-year-contract. The market has improved considerably since and prices compare as follows :—

Calcutta market.	April 1931.	March 1932.
Jubbulpore average	Rs. 1-14 per maund.	Rs. 2-3 per maund.
Jubbulpore No. 1	Rs. 2-5 per maund.	Rs. 2-10 per maund.
Crushed No. 1	Rs. 3-4 per maund.	Rs. 4 per maund.

Rusa oil.—Total revenue from this produce amounted to Rs. 4,185 against Rs. 3,725 of last year.

Tendu leaves.—Competition with supplies from private forests made itself felt.

Katha.—A good demand arose in the northern divisions during the year. The rights to manufacture *katha* were leased out with varying results, viz.:—

Saugor Rs. 10 to Rs. 14-8 per handi.

Damoh Rs. 14-4 to Rs. 29-8 per handi.

South Mandla Rs. 5 to Rs. 8 per handi.

The main sales were :—

	Rs.
South Mandla	2,488
Damoh	8,503
Saugor	4,515
Jubbulpore	2,100

Gum Karaya.—Damoh and Jubbulpore are the only two divisions where this gum is available in commercial quantities. Demand for it continued throughout the year. 28,087 cwts. were exported to foreign countries from Bombay during the last 9 months (July to March).

Further leases amounting to Rs. 3,325 were given out in the Damoh Division for 2-year and 3-year periods.

Horns.—The trade in this produce is very dull, consequently collection has been given up in most divisions.

Timber markets.—The characteristic of the year was the slump in prices, but a hopeful feature is that the demand for timber is on the increase. Where coupes have been sold standing to contractors who cater mainly for the local supplies of timber and fuel, the prices reached a very low level. In the outside market there was, if anything, an increase in demand and although two new depots were opened at Khirkiya and Elliehpur, no stocks have remained on hand, although lower prices had to be accepted. The latest reports show that in spite of the despairing complaints of contractors, they too have in many localities sold out their stocks.

The prospects are not so favourable where supplies to Government departments are concerned. The Gun Carriage Factory have practically ceased to buy first class logs. The G. I. P. Railway Workshops were also unable to place orders, and in the case of *sal* sleepers the numbers supplied were fewer and the rates lower.

The total departmental sales fell from rupees 7·83 lakhs to 5·31 lakhs.

II.—FOREST UTILISATION DIVISION.

The Local Government has now decided to retain the Forest Utilisation Division as a permanency—a step which is fully justified by the results achieved.

New markets have been found for the disposal of the first class timber which Government Workshops no longer can consume owing to measures of retrenchment. The fall in sales by 2½ lakhs is due to a large extent to the lower rates obtained for timber. It is gratifying that the sawn timber from the Allāpīllī Saw Mill has become very popular; in fact, the sales are limited by the capacity of the mill, and it will be a paying proposition to set up a second mill at Ballarshah to satisfy the increasing demand.

(ii) *Timber Preservation.*

Preservation of chil sleepers.—Further experiments with *chil* sleepers showed that (i) protection to the ends and sides of the sleepers save the timber from excessive degrade, (ii) painting the ends of sleepers lessens subsequent degrade, (iii) the axed surface of sleepers extracted from outermost part of the logs develop more cracks than the sawn face of the sleeper, due to the former containing more sapwood.

(iii) *Minor Forest Produce.*

Lac Cultivation.—Lac cultivation experiments carried out in Ho-hiar-pur and Rawalpindi East Divisions have given some success and efforts are being continued.

UNITED PROVINCES.

I.—GENERAL ADMINISTRATION.

Organised research on forest economy and utilisation has more or less ceased since November when the Utilisation Division was held in abeyance. Certain enquiries and experiments have been taken up from time to time which are noted on below.

II.—EXPERIMENTAL ACTIVITIES.

(i) *Dab* grass (*Eragrostis cynosuroides*) as a raw product for paper manufacture:—A large scale sample of 200 maunds of *dab* grass was sent in the previous year to the Upper India Conper Paper Mills Co., Ltd., Lucknow, for testing the production of cheap brown paper on a commercial scale. The Company report that the best result obtained was by fractional digestion with a mixture of caustic soda and sodium sulphide. It was not found possible to bleach the half-stuff sufficiently white for making printing paper, but a satisfactory sample of buff or half bleached paper was obtained; the Company propose to carry out further experiments. Meanwhile the Forest Research Institute have been asked for their opinion as regards testing some of the common grasses in *sal* forests of which large supplies are available.

(ii) *Umbrella Handles.*—The Wood Technologist, Bercilly, was supplied with some samples of *rohini* twigs (*Mallotus philippinensis*) and after test he has reported that twigs of this species 20" in length and 1" diameter are very suitable for bending into hilts of umbrella handles and has instituted enquiries regarding possibilities of cost and deliveries on a large scale.

(iii) *Pipe Timbers.*—The Wood Technologist, Bercilly, prepared half-wroughts of eight species, *viz.*—

1. Stem wood of *Dalbergia sissoo*.

2. Root wood of *Acacia catechu*.
3. Stem wood of *Albizia lebbek*.
4. Stem wood of *Terminalia tomentosa*.
5. Stem wood of *Ougeinia dalbergioides*.
6. Root wood of *Acacia arabica*.
7. Stem wood of *Schleichera trijuga*.
8. Stem wood of *Boehmeria rugulosa*.

These have been sent to the Timber Adviser to the High Commissioner for India for test. The Forest Research Institute suggested two more species, viz., *Rhododendron arboreum* and *Pieris ovalifolia*. Experiments with these two species are being carried out.

(iv) *Calorific value of fuel woods in the Chakrata Division*.—Five samples were supplied last year to the Forest Research Institute to determine their calorific values. The results were as follows:—

	<i>Abies webbiana</i> Lindl.	<i>Pinus roxburghii</i> Link.	<i>Quercus dilatata</i> Lindl.		<i>Quercus semicarpa</i> folia Smith		<i>Rhododendron arboreum</i>
			Sapwood	Heartwood	Sapwood	Heartwood	
Moisture in the air dry sample %.	17.71	12.14	11.83	11.77	14.68	14.70	18.76
Ash in the completely dry sample %.	0.80	0.40	0.33	0.66	0.80	0.47	0.63
Calorific value for completely dried materials, B.T.U.	0.180	8.900	8.827	8.560	8.024	8.020	8.007
Calories	5.100	4.018	4.793	4.750	4.791	4.792	4.940

(v) *Pintar*.—The experimental manufacture of *pintar* from highly resinous pieces of *chi* (*Pinus longifolia*) wood has been abandoned. The product is more expensive than *Spramax* and there is increasing demand for the wood at good prices.

(vi) *Bark of Litsea and Symplocos sebifera*.—The removal of bark from the bole of *Litsea sebifera* has not proved harmful, but when it is removed from the branches, particularly from small branches, the trees are seriously damaged. Bark grows about $\frac{1}{2}$ " in 3 years and a rotation of about 10 years is indicated.

In the case of *Symplocos sebifera* the bushes should be coppiced and barked. A rotation of 10 years is indicated.

CHAPTER IV.

FOREST BOTANY.

ASSAM.

The preparation of the Flora of Assam was continued during the year under Mr. P. C. Kanjilal who was lent to this Province by the United Provinces Government. As a measure of economy this arrangement was brought to an end, and with effect from 25th September 1931 Mr. A. Das has taken up the work assisting Mr. Kanjilal who continued the work voluntarily while on leave. The Flora has been practically completed up to *Gamopetalum* and part is now being printed.

BENGAL.

A large number of species are being grown for the first, or nearly the first, time in several divisions. Of our own species perhaps the experiments with *gokul* (*Ailanthus grandis*), *labshi* (*Polyalthia sinilarum*), *ralan* (*Lophopetalum fimbriatum*) and *angari* (*Phacelia attenuata*) in the Kalimpong and Jalpaiguri Divisions are the most interesting. Of exotics, experiments with conifers, including hoop-pine (*Arancaria cunninghamii*) and of various species of *Eucalyptus* in Darjeeling Division, and of *Lagerstramia hypoleuca* in Buxa and Kurseong Divisions are important. The experiments with *bonsum* (*Phacelia hainesiana*) in Kurseong are at a later stage and look promising, as do the *Cryptomeria* cuttings in plantations in Darjeeling and Kurseong.

New species are being raised in nurseries to test their suitability for plantations at various elevations. In the Hum nursery European beech is being tried among other exotics.

Mr. R. N. Parker toured the plains part of the Circle with Conservators of Forests and Divisional Forest Officers of the Divisions concerned. He concentrated mainly on the Linear Sample Plots where a maximum number of unidentified or doubtful species could be observed in a minimum time. As a result of his short tour few unidentified species remain in the Linear Sample Plots. At least two trees not previously reported from our area were identified (*Homalium zeylanicum* and *Diplospora singularis*) together with two more that need verification (*Brilschmiedia assamica* and *Cryptocarya griffithiana*). He was also able to separate *Cryptocarya amygdalina* from *C. floribunda* which had been united and verify in the field the distinction between *Litsea khasyana* and *L. panamonga* about which there had been some uncertainty.

BOMBAY.

Special attention was paid during the past year to the possible correlation between the occurrence of different species of grasses and the presence and development of tree species in the open dry mixed deciduous forests of the Deccan. It can now be definitely stated that the occurrence of *Anthistiria ciliata* as a dominant in the grass crop is an indicator of conditions suitable to the introduction and satisfactory growth of all mixed deciduous species including teak; whereas conditions of soil and climate which result in a predominant crop of *Aristida* species and *Andropogon contortus* are unfavourable to any tree growth other than thorn scrub. Excessive continuous grazing is a potent factor in extending the latter type of grass land while intensive intermittent grazing will gradually restore both the quality of the fodder and the potential ability of the soil to produce trees.

BURMA.

The post of the Forest Botanist, Burma, was vacant from the opening of the year till the 30th June, when Mr. Parkinson returned from the Forest Research Institute. In October a combined post of Forest Botanist and Forest Economist was created and in addition Mr. Parkinson became senior Lecturer in Botany at University College, Rangoon.

Herbarium.—During the year 4,653 specimens were added to the herbarium bringing the total up to 31,005 at the close of the year. This valuable collection, which is well representative of the woody flora of the province, continues to be maintained in its former excellent condition. It will be difficult to maintain it in this condition in the Rangoon climate, with its higher temperature and greater humidity, for at the time of writing some of the newer collections are showing a bad infection of mould and insect attack, but it is hoped that more frequent poisoning will bring this under control.

Collections of herbarium specimens were made chiefly by the staff of the Forest Botanist, these amounted to some 800 collections and were made chiefly in the Pyinmana, Thauingyin, Tavoy and Mergui Divisions.

In addition to the above more than 500 collections have been made in Rangoon by the Forest Botanist and his staff since the office has been transferred here.

Smaller collections of specimens have been received from several Forest Officers, chiefly from Messrs. A. H. M. Barrington, Conservator of Forests, and A. Long, Extra Assistant Conservator of Forests, and from the Divisional Forest Officer, Mogok.

Distribution of herbarium specimens to the following institutions were made during the year :—

Forest Research Institute and College, Dehra Dun.	. . .	207
Royal Botanic Gardens, Calcutta.	. . .	33
Royal Botanic Gardens, Kew	. . .	66
Royal Botanic Gardens, Edinburgh	. . .	46
TOTAL	. . .	352

Small quantities of seed were collected for the Botanic Garden at Maymyo, the Arboretum at Dehra Dun and for others.

Timber specimens.—The total number of timber specimens collected up to date by the Forest Botanist and his staff is 1,489. This collection forms the bulk of the collection of hand specimens in the office of the Conservator of Forests, Utilization Circle. The identity of these specimens rests on herbarium specimens, collected from the same trees from which the timber specimens were obtained, which are incorporated in the herbarium. The work of naming is now practically complete.

The number of duplicate wood specimen blocks in stock when the office was shifted from Maymyo to Rangoon was 2,373. During the year a collection of 46 specimen blocks, belonging to the family Dipterocarpaceae was sent to the Wood Technologist at Dehra Dun leaving 2,327 blocks in hand at the close of the year.

Very few timber specimens were collected during the year owing to the insufficiency of funds to meet the cost of this work.

Tours.—Short tours were made by the Forest Botanist's staff in the Pyinmana, Thaungyin, Tavoy and Mergui Divisions.

Research.—The period 1st July to 27th October was spent in the systematic examination of herbarium material and the writing up of descriptions for the preparation of a handbook of the Trees, Shrubs and Woody Climbers of Burma. This work, which involves the examination of a large number of specimens, is necessarily slow. The examination and description of plants belonging to the following families was, for the most part, completed :—Ranunculaceae, Dilleniaceae, Magnoliaceae, Anonaceae, Capparidaceae, Bixaceae, Flacourtiaceae, Pittosporaceae, Polygalaceae, Hypericaceae, Guttiferae, Ternstroemiaceae, Dipterocarpaceae, Ancistrocladaceae, Malvaceae, Sterculiaceae, Tiliaceae, Meliaceae and some of the larger genera in the family Papilionaceae like *Desmodium* and *Dalbergia*. Selected specimens of plants belonging to these families have been sent to Kew for check or determination by comparison with types.

In addition to the above the herbarium material of the following families was examined, identified and arranged preparatory to writing the descriptions :—Menispermaceae, Malpighiaceae, Simarubaceae, Rham-

naceae, Sapindaceae, Salicaceae, Anacardiaceae, Connaraceae, Rhizophoraceae.

This work was interrupted on the transfer of the Forest Botanist to Rangoon.

"A note on the Burmese species of the genus *Dipterocarpus*" was completed (Forest Bulletin No. 27), and a note on Burmese *Lagerstroemias* (Forest Bulletin No. 23) was issued.

Flowering specimens of two new species of bamboos have been collected during the year. These occur in Tenasserim and up till now have been known only by their Burmese names *kyat-ra* and *tamyin-ra*. Both occur fairly plentifully on the drainage of the Tenasserim river and are of some economic importance, especially the former, *kyat-ra*, which is of a type similar to the useful *tinca*. *Kyat-ra* will shortly be described under its proposed name *Cephalostachyum burmanicum*. The writer is in correspondence with Dehra Dun regarding the identity of *tamyin-ra*.

CENTRAL PROVINCES AND BERAR.

Fungal disease of sal.—A mysterious fungal attack appears to have caused the death of a number of *sal* trees in compartments 371 and 372 of Birgadi Range (South Raipur). The matter is being further investigated.

Fomes pappianus.—This fungus continues to attack *babul* in the Bhongaon reserve (Buldana) selecting principally young plants particularly those whose vitality has been lowered by borer attack.

PUNJAB.

Succession of vegetation in burnt area.—Two experimental plots have been laid out in Lower Bashahr Division to study the succession of vegetation in burnt forest areas (December 1930 fires). Observations are being made in marked linear plots twice in a year, in April-May and again in August-September, and the frequency of various plants in them is being recorded. The unknown plants met with in the course of 1931 observations were collected and have been identified by the Forest Botanist at Dehra Dun.

Vegetation in spruce and silver fir forests.—The associate vegetation in various types of spruce and silver fir forests in Kulu Division is being studied. The unknown plants are being collected and most of them have now been identified by the Forest Botanist at Dehra Dun.

CHAPTER V.

FOREST ENTOMOLOGY.

ASSAM.

A definite attack by the larvae of *Dihammus cervinus* and *Phassus* sp. was noticed in the Poba, Pasighat and Sadiya plantations. The attack of *Dihammus* in the Poba Reserve seems to be in epidemic form, but only sporadic attacks were noticed in the other plantations.

Specimens of toon (*Cedrela toona*) borer *Hypsipyla robusta* Moore were sent from Sylhet to the Forest Research Institute for identification.

In Sylhet also *Calopepla leayana* beetles were collected and destroyed as suggested by the Forest Entomologist.

BENGAL.

The following microlepidoptera have emerged from the specimens of *lali* (*Amoora wallichii*) wood, which were sent for identification.—(1) Several specimens of *Arctoscelis epincyta* Meyrick (Oecophoridae) and (2) a single example of *Pyroderces semicoccinea* Stainton (Cosmopterygidae).

Towards the close of the year, a few more specimens of insect infested *lali* (*Amoora wallichii*) wood were sent to the Forest Research Institute for further study of the habits of these caterpillars.

The roots and leading shoots of a *Michelia champaca* tree which was found dying from the top in Rajabhatkhawa 1922 plantation were also sent to the Forest Research Institute for finding out the cause of death, but no sign of insect attack to which the death of the tree can be attributed was noticed in examination.

BIHAR AND ORISSA.

A start was made in the year under report to collect specimens of insects. Considerable numbers of specimens were collected and sent for identification to the Forest Research Institute. The life histories of all these insects are now written up. As they have not been found to be doing damage of any great extent to our forests except *Euclemma amabilis* which did considerable damage to lac in the Santhal Parganas Division, no remedial measures have so far been taken in the case of any of these insects. In the case of *Euclemma amabilis* mechanical measures were applied to stop future propagation and were partially successful.

BURMA.

As the report of the Forest Zoologist, Burma, will be published in full elsewhere only a summary is given here. The greater part of the report from Burma deals, as one would expect, with teak pests, *Xyleutes ceramica* Walk., the Bee-hole Borer, receiving particular attention.

Difficulty was found in rearing larvae from eggs laid by "tame" moths for life-history studies; there are now however three localities stocked with young larvae and it is hoped that some of these will be able to complete their life cycle. It is probable that male moths require a flight period before the act of fertilisation, the captive female moths under observation can be fertilised by "wild" males attracted to them. In Plot I (Thogale, S. Toungoo) 405 beeholes were recorded in May 1931 and these were reduced, almost entirely through the agency of woodpeckers, to 50 in March 1932. Observations are recorded which strengthen the view expressed in last year's report as to the connection between beehole incidence and rainfall. "The quality of the teak itself is, of course, correlated with the rainfall, and while it is probably true that the optimum habitat of the teak is also the optimum habitat of the borer, it appears likely that the range of the host is greater than that of its parasite and that towards the limits of the tree's range the borer is either absent or occurring in such small numbers as to be negligible. Such an incidence as 12 or 15 beeholes per 100 tree years is of little importance—to put it another way it means that, on the average, a tree 100 years old might be expected to show 12 beeholes only—and this figure, it must be remembered, includes *all* beeholes of whatever size, probably less than 50 per cent. of which would be big enough to affect the timber seriously. There would thus seem to be indications that it might be of advantage to pay more attention to artificial regeneration in areas approaching (but not of course at) the limits of the tree's range, in preference to concentrating all our energies within what may be the optimum habitat of the tree but is at the same time the optimum for the borer also."

Observations on the life histories of the teak defoliators *Hyblosa puera* and *Hapalia machaeralis* were continued and also of the parasites of the latter.

Calopepla leayana Latr.—"Attack by this insect in the *Omelina* plantations at Namtu was very serious during the past rains, and having been preceded by fairly heavy defoliation during the previous two or three years and accompanied during the year by a reduced and unfavourably distributed rainfall, has resulted in the almost complete ruination of much of the planted area of the Railway Series (Nahkun). The rains were apparently characterised by long dry spells, particularly during

the early months while the first generation was maturing, which was extremely favourable to the insect, and conversely, probably unfavourable to the host plant. It was, moreover, noticed that *yemane* in the surrounding natural forests was badly defoliated during the year. By the end of June the greater part of the plantations had been completely defoliated, from which condition they did not recover before defoliation was again complete in September. When visited in March 1932 they presented a sorry picture, the trees having been killed back to the ground in those areas where growth had never been good, and being covered with short stunted epicormic branches in the better areas." "During a visit in March large numbers of beetles were found in hiding under the bark of dead trees standing in the natural forest around the plantations, and it was therefore recommended that systematic search should be made for these quarters and all beetles destroyed—this was done, and many thousands of beetles must have been thus accounted for. The artificial traps mentioned in last year's report were tried out, but were not very successful—something over a hundred beetles were taken from them, and all these were at the very top, about six feet above the ground—had the traps been double this height it is possible that they would have been more attractive. It is probable that the beetles did not find them, hidden as they were well below the crowns of the trees." Special attention is being paid to the common parasite of *Calopepla leayana* with the object of breeding large numbers for liberation at the appropriate time.

Northern Shan States.

The attack of the *yemane* defoliating beetle *Calopepla leayana* in the regeneration areas of Paungnai Reserve was very much more serious than in any previous year, but with the exception of a very slight attack in two isolated patches of 1930-31 plantation in Compartment 11, where only one generation of the beetle made its appearance and no damage was done, it was again confined to the plantations in the Railway Series.

The climatic conditions during the year appeared to have been peculiarly favourable to the pest and besides making its attack on the plantations it was found extensively on *yemane* trees growing in the surrounding natural forests.

The attack commenced at the top of the 1926-27 and 1927-28 plantations of Compartment 20 early in the rains, the first signs of the eggs of the beetle being noticed about the middle of May although it is probable that egg-laying commenced earlier than this and was not noticed as the Forest Zoologist (Burman) states that in his cages at Maymyo the first

eggs were found on April 23rd. The attack spread rapidly throughout the 1926, 1927 and 1928 plantations of Compartment 20 which were completely defoliated by the end of June and remained more or less in that condition for the rest of the season as new shoots were eaten up as soon as they made an appearance.

From Compartment 20 the insects rapidly crossed the railway into Compartment 19 where they did very considerable damage in the 1930-31 plantation which did not do very well in its first year and on account of being defoliated during its second year is still inferior in height growth to an average plantation at the end of its first rains. This will very considerably increase the cost of weeding, etc., in this area during its first five years. The 1929-30 plantation of Compartment 19 was less seriously attacked and as it did well in its first two years it should not have suffered any serious damage if it escapes attack again in 1932-33.

Hand picking of the adult beetles took place over all the above mentioned areas and some five lakhs of beetles were destroyed but it is probable that the majority of these were beetles of the year which it is not worth attempting to destroy in this way. During 1932 hand picking will not be continued beyond the middle of June.

Five traps for hibernating beetles of a pattern recommended by the Forest Zoologist were set up as an experiment but were not very successful. The beetles apparently do not hibernate at less than five feet from ground level. The traps themselves are expensive and to raise them up to this level would make them far more so as they would need legs and guy lines to prevent them being blown over.

The *Chalcid* pupal parasiter were again common in the attacked areas and must have destroyed a number of pupae of *Calopepla layana*. It is proposed during the coming rains to try breeding up large numbers of these parasites and releasing them at the centres of worst infection.

The systematic destruction of all beetles hibernating under the bark of dead trees within two hundred yards of the boundaries of the plantations was commenced towards the close of the year.

CENTRAL PROVINCES AND BERAR.

Hoplocerambyx spinicornis.—In South Mandla the attacks of this *sal* borer continued in endemic form. Owing to the late monsoon emergence of the beetle was very late. Trap tree operations were undertaken all over the division, but few beetles were caught except in portions of Motinala and Banjar Ranges and the bulk of the catch was made in a fortnight.

Coclesternu scabrata.—This borer continues to cause serious damage to *babul* in the Bhongaon reserve (Buldana). In Akola and Amraoti,

as a result of the heavier monsoon, previously attacked trees seemed to be mostly recovering.

PUNJAB.

Shisham defoliator (*Placcoptera reflexa*) which generally appears in the Khanewal Plantation in April did not appear this year till the 1st week of June 1932. This may be due to 8 irrigations given in 1931 against 5 in 1930 or to its parasites having exterminated it. This insect is no longer dangerous. The bag worm on *chil* in Rawalpindi has been entirely destroyed by crows.

CHAPTER VI.

FOREST CHEMISTRY.

BIHAR AND ORISSA.

A study has been made of the soils of *Casuarina* plantation ; at one time, mortality in the plantation was ascribed to the acid nature of the soil, but this theory has now been abandoned as the analyses of soils from different parts of the plantation give definitely alkaline reaction.

The soils of the Hinoo nursery and of the damp areas of Puri in Tamna Compartment II have also been examined.

BURMA.

FOREST CHEMISTRY.

In Burma plantations are being formed on a large scale and cannot be restricted entirely to soils on which the same species grew well before. The object of the investigation is therefore to explain the distribution and range of growth of the more important trees in relation to the soils on which they occur.

Provisional conclusions arrived at from the analytical figures, vegetation, climate, etc., are as follows :—

The upper 3"—4" of soil determines the predominance of *Indaing* which grows on the lightest soils irrespective of rainfall. Regeneration ceases if the light surface soil is lost or if floods deposit clay on the surface and *Indaing* may therefore be left stranded on a non-typical soil if it has become established there before. Usually these soils are faintly acid.

Teak is dominant on soils closely allied to *Indaing* and frequently occurs growing well on soils devoid of free carbonates.

Teak on medium soils appears to grow excellently without free carbonates while its presence in laterites also shows its independence of carbonates. It is probably only on the stiffer soils where carbonates are necessary.

Ingyin soils form a compact group in which the texture index usually diminishes as the depth increases.

Xylia laterite is common north of Rangoon and appears to be derived from Rangoon laterite by erosion.

Pyinkado has often been planted on soils considered too heavy for teak. There is reason to think this a mistake. *Pyinkado* appears to avoid calcareous soils. It is likely to grow as well as teak on Rangoon laterite soils, but its real habitat is in the climax moist deciduous forest.

Taukkyan is dominant on calcareous scrub, on one dry deciduous medium, on one alluvial lower mixed, on one *ingyin* and on three moist deciduous forest soils. It is a widespread species but is probably excluded from the best soils by teak and *pyinkado*. It is characteristic of heavy soils, calcareous or not, but grows after a fashion on *Indaing* sands and dry dipterocarp soils generally.

The sample plots Nos. 54-61 were selected and soils collected by Mr. Barrington. These are all in the Sittang Circle. The table below shows the size, position, climate and dominant trees on each :—

Plot No.	Size sq. ft.	Geographical position.	Rainfall inches.	Dominant trees.
54	50	10° 12' N 96° 12' E	70	<i>Taukkyan</i> (<i>Terminalia tomentosa</i>) 130' high, 9' 4" girth. Teak commonest local species.
55	50	10° 18½' N 96° 12' E	70	<i>Kanyin</i> (<i>Dipterocarpus turbinatus</i>) 126' high, 10' girth. <i>Pyinkado</i> (<i>Xylia dolabriformis</i>) 96' high, 5' 3" girth. <i>Padaul</i> (<i>Pterocarpus macrocarpus</i>) 90' high, 7' 5" girth.
56	50	10° 20½' N 96° 26' E	90	<i>Padaul</i> (<i>Pterocarpus macrocarpus</i>) 128' high, 9' 9" girth. Teak, 96' high, 8' 5" girth, a dead <i>pyinkado</i> 4' 7" girth.
57	50	10° 20½' N 96° 26' E	90	3 <i>kanyin</i> trees of 12', 10' 10" and 8' 1" breast girth with a minimum height of 141 feet.
58	53	10° 13½' N 96° 29½' E	90—100	<i>Thitya</i> (<i>Shorea obtusa</i>) 114' high, 8' 3" girth.
59	50	18° 49' N 96° 34' E	100	3 <i>in</i> (<i>Dipterocarpus tuberculatus</i>) 7' 5", 5' 10", 4' 10" girth, the best tree being 102 feet high.
60	50	18° 38' N 96° 43' E	100	<i>Pyinkado</i> 112' high, 5' 4" girth.
61	50	18° 28' N 96° 45½' E	100	<i>Pyinkado</i> 124' high, 9' 6" girth.

Plot No. 54.—This is a plot dominated by *taukkyan*. The soil is a light one, the texture index increasing with depth except at 3"—14" where it is slightly lower than the surface first three inches. Exchangeable bases also increase with depth which is characteristic of soils dominated by *taukkyan* with teak.

Plots Nos. 55, 57 and 58.—The first two are *kanyin* plots and the third a *thitya* plot. Exchangeable bases in all the three plots are low. They are acid at all horizons. The maximum texture index for No. 55 is 6.97 at 23"—35". Nos. 56 and 57 are comparatively stiffer soils, their maximum texture index being 24.52 and 27.63 respectively.

Plot No. 56.—This is a *padauk*-teak plot. It is a medium soil, maximum texture index being 19.66. It is rich in organic Nitrogen and deficient in CO₂. It is acid, the maximum pH value being 6.60 at the surface. The exchangeable bases decrease with depth.

Plot No. 59.—This is a typical *Indaing* plot. Up to 2 feet from the surface, the soil is coarse and from 2 feet downwards it becomes comparatively stiffer. Colloidally held moisture is *nil* up to 2 feet except in the first three inches from the surface where it is as low as 1.21. It is acid throughout. Total milli-equivalents of exchangeable bases do not exceed 2.87 except in the first three inches where they are 4.37.

Plots Nos. 60 and 61.—These are *pyinkado* plots. Both are laterite soils. Soil No. 60 at 3' 4"—4' 4" is comparatively very coarse, the texture index being only 8.08 while the texture index at other horizons range between 22.49 and 33.54. In No. 61, 1' 9"—3' is the enrichment horizon, and the soil is very stiff up to 3 feet. The 3'—5' horizon is coarse sand, the texture index being only 4.46. The total exchangeable bases in both the soils are low at all horizons.

Federated Shan States.

Soil analysis were continued during the year. Seventy soil samples were taken and sent to Mr. J. Charlton, Agricultural Chemist, Mandalay, for analysis; he prepared a detailed report on them together with forecasts of the results of planting the areas sampled. Extracts of his report are quoted below.

The samples were taken from the following areas:—

Pit number.	Compartment number.	Year of plantation.
1 to 20	12	1932-33
21 to 60	8	1932-33
61 to 70	19	1933-34

It seems early at present to compare the actual results of planting up the 1931-32 area in Compartment 11 with Mr. Charlton's forecasts, as the growth in the year of planting is very much affected by the fierceness of the *taungya* fire. It is proposed to prepare a map of the areas at the end of the second rains showing the rate of growth of the *yemane* in various parts of the plantation and to compare this with the forecasts made as the result of soil analysis and with a map showing the nature of the fire.

Mr. Charlton considers that the following conclusions are justified:—

"(1) Good soils are immature soils without definite profile development. It is to be noted that a soil deteriorates as it matures (*i.e.*, as a profile develops). This is in accordance with Mr. Barrington's observation regarding forests in the Hlning Circle *vide* Burma Forest Bulletin No. 25, page 10.

(2) The primary requirements of a good soil for *yemane* are a soil of low lime requirement, preferably diminishing with increased depth up to 4'.

(3) A secondary requirement for good growth of *yemane* is that the soil shall not be too heavy in texture.

"Applying these assumptions again to the 70 soils examined in 1931, it will be found that further explanation is unnecessary except in the following cases:—

"Pit No. 14. This is a yellow soil of a type of which no previous sample has been submitted. By the tests applied it ought to give good growth.

"Pit No. 15.—This black alluvium differs from a black alluvium examined previously inasmuch as it is sour as well as rather heavy. I expect only medium growth.

"Pit No. 64.—This is a yellow alluvium of a type not hitherto examined. Although it is light in texture it is very acid indeed, so I expect poor growth.

"The fact that soils Nos. 5, 26, 35, 38 and 42 are calcareous at the surface is a new phenomenon. Although *yemane* apparently dislikes sour soils, it does not follow that it will do well on soils calcareous at the surface. This point will require careful watching.

"The classification is therefore very complete indeed and planting up of the areas comprising sample pits Nos. 1—70 should in all probability settle the whole problem of the growth of *yemane*. The conclusions drawn are of course somewhat risky but they are at least in accordance with what data exist at the moment and I do not therefore anticipate any violent reversal of opinion."

PUNJAB.

All soil samples taken in Changa Manga plantation during the year to determine relative water loss from soils with different covers *viz.*, bare soil, soil with only tree cover, soil with only grass cover and soil with both tree and grass cover, were analysed at the Forest Research Institute, for moisture content. A full range of soil samples taken in different types of vegetation in the spruce and silver fir forests of Kulu Division could not be analysed for moisture content, physical and chemical composition.

An investigation was carried out on the different soils of Khanewal plantation, but the chemical analysis could not be correlated with the differences in growth on different parts of the plantation.

APPENDIX I.

List of Forest Publications of 1931-32 (excluding the Forest Research Institute).

ASSAM.

Indian Forester Articles :

Sal plantation in grassland of Upper Assam. A. K. Adhikari

Taungya in Garo Hills Division. R. N. D.

BIHAR AND ORISSA.

Forest Bulletin No. 2.—Commercial Timber (Katha) and Heartwood Volume Tables for Khair (*Acacia catechu*), by L. R. Sabharwal.

Indian Forester Article: Notes on a *Casuarina* plantation at Puri. L. R. Sabharwal.

BOMBAZ.

Indian Forester : An experiment in the improvement of grassland, by W. Burns.

BURMA.

Forest Bulletin No. 23.—A Note on Burmese *Lagerstroemias*, by C. E. Parkinson.

Forest Bulletin No. 24.—Experiments in connection with Sowing and Planting Teak in *Taungya* Plantations, by H. R. Blanford.

Forest Bulletin No. 25.—Forest Soil and Vegetation in the Hlaing Forest Circle, by A. H. M. Barrington.

Forest Bulletin No. 26.—On Insect Damage to the Timber of Teak (*Tectona grandis*), by D. J. Atkinson.

Forest Bulletin No. 27.—A Note on the Burmese Species of the Genus *Dipterocarpus*, by C. E. Parkinson.

Forest Bulletin No. 28.—Tests in the Rangoon River on the damage by Marine Borers to various woods, including Burma Teak and British Guiano Greenheart, crossbanded and not treated.

Key to the identification by hand lens of 20 of the chief timbers of Burma, by C. W. Scott (Economic Series, Pamphlet No. 5).

Burma Timbers for the Bengal Markets, by the Conservator of Forests, Utilisation Circle (Economic Series, Pamphlet No. 6).

Note on the use of Burmese Timbers for the manufacture of Box-shooks and Packing Cases, by A. N. Barker (Economic Series, Pamphlet No. 7).

Note on Timbers of Burma—in and *kangin*—*Dipterocarpus tuberculatus* and *D. alatus*, *D. turbinatus*, etc. (Leaflet.)

Definitions of standard defects for timbers for the Indian Railways. (Leaflet.)

General quality specification for timber for export. (Leaflet.)

A note on comparison of the timbers of Burma with those of Europe and America as regards strength and other properties—A paper prepared and read by Mr. C. W. Scott before the Association of Engineers in Burma.

*Indian Forester Articles:*Regeneration of *in* (*D. tuberculatus*) in Yinnw R Ummw.Natural Regeneration of *pyungado* (*X. dolabriformis*) after a good seed year.
H. R. Blanford.

CENTRAL PROVINCES

Indian Forester: Shoots produced by *aygan* (*H. binata*). K. P. Bagrecha.

MADRAS.

Indian Forester:

Teak and its lime requirements M. V. Laurie.

Notes on lac cultivation in Hosur. S. Rangaswami.

PUNJAB.

Forest Leaflet No. 1.—Thinnings.

Forest Leaflet No. 2.—Natural regeneration of conifers.

Forest Leaflet No. 3.—Forest nursery work in the hills

Forest Leaflet No. 4.—Artificial reproduction in the hills

Forest Leaflet No. 5.—Closures

Forest Leaflet No. 6.—The burning of slash.

A Manual on the Punjab Irrigated Plantations compiled by Sardar Salub Bahadur Singh was also published

Notes on the following subjects were circulated within the province:—

Propagation of *bhabar* grass.Silviculture and cultivation of *Cryptomeria japonica*.

Tube planting.

Afforestation in the Pabbi Hills.

Olive cultivation.

Indian Forester:

Erosion in Punjab Himalaya and its probable effect on water supplies L. B. Holland and H. M. Glover.

Notes on *Pinus gerardiana*. R. M. Gorrie

Ecological changes and need for survey of soil flora H. M. Glover.

Notes on sheep grazing in coniferous forests N. G. Ping.

Bamboo forests of Hoshiarpur. Fatch Mohd.

Felling cycle and rotation in bamboo forests. N. P. Mohan.

Natural regeneration of silver fir. A. E. Osmaston.

UNITED PROVINCES.

Bulletin No. 5—*Acacia catechu* (*Khair*) Root and Shoot Cuttings, by M.D. Chaturvedi.Bulletin No. 6—Volume Tables for *Ban Oak* (*Quercus incana*, Roxb.), by the same author.

Bulletin No. 7.—Deer Damage to *Shorea robusta* (*Sal*) Reproduction, by the same author.

Indian Forester :

Sal regeneration felling. D. Davis.

Regeneration of *sal* in U. P. M. D. Chaturvedi.

Seasonal growth of *sal* seedlings. M. D. Chaturvedi.

Gauj in the Haldwani *sal* areas. M. D. Chaturvedi.

Retention of standards in *sal* regeneration areas susceptible to hill frosts. M. D. Chaturvedi.

APPENDIX II.

Statement showing rank, designation and address of Forest Research Officers in the various Provinces, as it stood on 1st July 1932.

Serial No.	Name.	Designation.	Address.
1	Mr. O. K. Homfray, Deputy Conservator of Forests.	Silviculturist, Bengal .	Darjeeling.
2	Mr. T. M. Coffey, Deputy Conservator of Forests.	Forest Utilisation Officer, Bengal.	Do.
3	Mr. B. P. Basu, Deputy Conservator of Forests.	Forest Research Officer, Bihar and Orissa.	Ranchi.
4	Mr. F. C. Ford Robertson, Deputy Conservator of Forests.	Silviculturist, United Provinces.	Naini Tal.
5	Mr. Parina Nand Suri, Extra Assistant Conservator of Forests.	Divisional Forest Officer, Silvicultural Research Division.	Lahore.
6	Mr. H. S. Genge, Deputy Conservator of Forests.	Superintendent of Working Plans and Research, Central Provinces.	Betul.
7	Mr. Tara Singh, Deputy Conservator of Forests.	Silviculturist, Central Provinces.	Balaghat.
8	Mr. G. S. Shirley, Deputy Conservator of Forests.	Silviculturist, Burma .	Maymya.
9	Mr. T. Allsop, Deputy Conservator of Forests.	Forest Economist, Burma .	Rangoon.
10	Mr. C. F. Parkinson, Deputy Conservator of Forests.	Forest Botanist, Burma	. Do.
11	Mr. J. A. Wilson, Deputy Conservator of Forests.	Forest Utilisation Officer, Madras.	Madras.
12	Mr. W. G. Dyson, Deputy Conservator of Forests.	Silviculturist, Madras .	Ootacamund.

APPENDIX III.

List of Publications by the Forest Research Institute, Dehra Dun.

I.—BULLETINS (OLD SERIES).

	PRICE (exclusive of packing, postage, etc.).
Rs. A. P.	
1. Note on the Bee-Hole Borer of Teak in Burma, by E. P. Stebbing. (<i>Out of print</i>)	
2. Note on the Quetta Borer (<i>Aeolesthes sartus</i>), by the same author	0 8 0
3. Note on the Chilgora (<i>Pinus Gerardiana</i>) Bark Boring Beetles of Zhob, Baluchistan, by the same author	0 8 0
4. <i>Ficus elastica</i> : its natural growth and artificial propagation, with a description of the method of tapping the tree and of the preparation of its rubber for the market, by E. M. Coventry	0 12 0
5. Notes on a Visit to some European Schools of Forestry, by E. P. Stob- bing. (<i>Out of print</i>)	..
6. Memorandum on Mechanical Tests of some Indian Timbers, by W. H. Everett	0 2 0
7. Note on the Chilgora Forests of Zhob and the Takht-i-Suliman, by E. P. Stebbing. (<i>Out of print</i>)	..
8. Note on the Life-History of <i>Hoplocerambyx spinicornis</i> (The Singh- bhum Sal Borer), by the same author	0 9 0
9. Note on the Influence of Forests on the Storage and Regulation of the Water-Supply, by S. Eardley-Wilmot. (<i>Out of print</i>)	..
10. Note on the Duki Fig-Tree Borer of Baluchistan. (<i>Batocera rubus</i>), by E. P. Stebbing	0 7 0
11. On Some Assam Sal (<i>Shorea robusta</i>) Insect Pests, by the same author	1 10 0

II.—LEAFLETS—(All Out of print.)

1. The Sal Bark-Borer (<i>Sphaerodrypes sivalikensis</i> , Steb.), by E. P. Stebbing	..
2. The Teak Defoliator (<i>Hyblaea puera</i> , Cram.), by the same author	..
3. The Teak Leaf Skeletoniser (<i>Pyrausta nathalis</i> , Wlk.), by the same author	..
4. The Larger Deodar Bark-Borer (<i>Scolytus major</i> , Steb.), by the same author	..
5. The Blue Pine "Polygraphus" Bark-Borer (<i>Polygraphus major</i> , Steb.), by the same author	..

III.—PAMPHLETS.

1. Note on Utilisation of Khair Forests in Eastern Bengal and Assam, by Purnan Singh. (<i>Out of print</i>)	..
2. The Attack on the Bark-Boring Beetle in the Coniferous Forests in the Simla Catchment Area, by E. P. Stebbing. (<i>Out of print</i>)	..
3. A Glossary of Forest Technical Terms for Use in Indian Forestry, by A. M. F. Cooch. (<i>Out of print</i>)	..
4. Note on Lao and Lao Cultivation, by D. N. Avasthi. (<i>Out of print</i>)	..
5. Notes on Sal in Bengal, by A. L. McIntire. (<i>Out of print</i>)	..
6. Note on Forest Reservation in Burma in the Interests of an Endan- gered Water-Supply, by A. Rodger	1 0 0

III.—PAMPHLETS—*contd.*

	PRICE (exclusive of packing, postage, etc.).
RS. A. P.	
7. Note on Andaman Marble Wood or Zebra Wood (<i>Diospyros Kurzii</i> , Hiern.), by R. S. Troup. (<i>Out of print</i>)	..
8. Note on the Collection of Statistical Data relating to the principal Indian Species, by A. M. F. Caccia	0 10 0
9. Tables showing the Progress in Working-Plans in the Provinces outside the Madras and Bombay Presidencies up to 31st December, 1908, by the same author	0 10 0
10. Note on Burmese Leza Wood (<i>Lagerstræmia tomentosa</i> , Presl.), by R. S. Troup	0 2 0
11. Note on Carallia Wood (<i>Corollia integerrima</i> , DC.), by the same author. (<i>Out of print</i>)	..
12. Note on Potwun or Trincomali Wood (<i>Berrya Ammonilla</i> , Roxb.), by the same author. (<i>Out of print</i>)	..
13. Note on Burmese In Wood (<i>Dipterocarpus tuberculatus</i> , Roxb.), by the same author. (<i>Out of print</i>)	..
14. Note on Burma Padank (<i>Pterocarpus macrocarpus</i> , Kurz.), by the same author. (<i>Out of print</i>)	..
15. Note on the Preservation of Bamboos from the Attacks of the Bamboo Beetle or "Shot-Borer", by E. P. Stebbing	0 7 0
16. Note on the Best Season for Coppice Follings of Teak (<i>Tectona grandis</i>), by R. S. Hole	0 4 0

IV.—BULLETINS (NEW SERIES).

1. Note on Calorimetric Tests of some Indian Woods, by Puran Singh	0 2 0
2. Memorandum on Teak Plantations in Burma, by F. A. Leete	0 10 0
3. Note on the Relative Strength of Natural and Plantation-Grown Teak in Burma, by R. S. Pearson	0 4 0
4. Second Edition of the Glossary of Technical Terms for Use in Indian Forestry, by A. M. F. Caccia, revised by R. S. Troup (<i>Revised and issued as Forest Record, Vol. XV, Part II</i>)	..
5. The Blue Pine Tomticus Bark-Borer (<i>Tomticus Ribbentropi</i>), by E. P. Stebbing	0 2 0
6. Memorandum on the Oil-Value of Sandalwood, by Puran Singh	0 2 0
7. Note on the Chemistry and Trade Forms of Lac, by the same author	0 3 0
8. Note on some Germination Tests with Sal Seed (<i>Shorea robusta</i>), by R. S. Troup	0 2 0
9. Note on Resin-Value of <i>Podophyllum Emodi</i> and the best season for collecting it, by Puran Singh	0 1 3
10. Note on the Bark-Boring Beetle Attack in the Coniferous Forests of the Simla Catchment Area, 1907-1911, by R. S. Hole	0 3 0
11. A Further Note on some Casuarina Insect Pests of Madras, by V. Subramania Iyer	0 14 0
12. Note on the Bark-Eating and Root-Boring Beetles of Babul (<i>Acacia arabica</i>), by E. P. Stebbing	0 4 0
13. Note on <i>Ligno Protektor</i> as a possible means of preventing timber from splitting while seasoning, by R. S. Pearson	0 5 0
14. A Further Note on the Relative Strength of Natural and Plantation-Grown Teak in Burma, by the same author	0 3 0
15. Note on the Technical Properties of Timber with special reference to <i>Oedra Toona</i> wood while seasoning, by the same author	0 3 0
16. Note on Gumhar (<i>Gmelina arborea</i> , Roxb.), by A. Rodger	0 3 0
17. Note on Bija Sal or Vengai (<i>Pterocarpus Marsupium</i> , Roxb.), by the same author	0 4 0

IV.—BULLETINS (NEW SERIES)—*contd.*

	Price (exclusive of packing, postage, etc.).
Rs. A. P.	
18. Note on Sain or Saj (<i>Terminalia tomentosa</i> , W. and A.), by the same author	0 5 0
19. Note on Benteak or Nana Wood (<i>Lagerstræmia lanceolata</i> , Wall.), by the same author	0 3 0
20. Note on Sandan (<i>Ougeinia dalbergioides</i> , Benth.), by the same author	0 3 0
21. Note on Dhaura Bhaki (<i>Anogeissus latifolia</i> , Wall.), by the same author	0 4 0
22. Note on the Causes and Effects of the Drought of 1907 and 1908 on the Sal Forests of the United Provinces, by R. S. Troup	0 5 0
23. Note on the Preparation of Indian Forest Floras and Descriptive Lists, by R. S. Holo	0 4 0
24. Note on Turpentine of <i>Pinus khasya</i> , <i>Pinus Merkusi</i> and <i>Pinus excelsa</i> , by Purnan Singh	0 2 0
25. Development of the Culms of Grasses, by R. S. Holo	0 2 0
26. Note on the Resin Industry in Kumaon, by T. A. Smythies	1 4 0
27. Note on Blackwood (<i>Dalbergia latifolia</i> , Roxb.), by E. Benkskin	0 4 0
28. Note on Dhauri (<i>Lagerstræmia parviflora</i> , Roxb.), by the same author	0 4 0
29. Note on Sundri Timber (<i>Heritiera minor</i> , Lam.), by R. S. Pearson	0 3 0
30. The Compilation of Girth Increments from Sample Plot Measurements, by R. S. Troup	0 2 0
31. Note on Indian Sumach (<i>Rhus Colinus</i> , Linn.), by Purnan Singh	0 2 0
32. Note on the Burma Myrobalans or "Panga fruits" as a Tanning Material, by Purnan Singh	1 2 0
33. Note on an Inquiry by the Government of India into the Relation between Forests and Atmosphere and Soil Moisture in India, by M. Hill	1 6 0
34. Note on Red Sanders (<i>Pterocarpus santalinus</i> , Linn. f.), by T. A. Whitehead	0 9 0
35. Note on Babul (<i>Acacia arabica</i> , Willd.), by J. D. Maitland-Kirwan	0 5 0
36. Note on Kokan and Lampatia Timber (<i>Duabanga sonneratioides</i> , Ham.), by R. S. Pearson	0 3 0
37. Note on the Contraction and Warping which takes place in <i>Pinus longifolia</i> timber while seasoning, by the same author	0 11 0
38. The Construction of Calcareous Opercula by Longicorn Larvæ of the Group <i>Cerambycini</i> (Coleoptera, Cerambycidae), by C. F. C. Beeson	0 3 0
39. Note on Hollong Timber (<i>Dipterocarpus pilosus</i> , Roxb.), by R. S. Pearson	0 4 0
40. Note on Pyinma, Ajhar or Jarul Wood (<i>Lagerstræmia Flos-Negina</i> , Retz.), by the same author	0 0 0
41. Note on Weights of Seeds, by S. H. Howard, Revised by H. G. Champion	0 8 0
42. Note on Haldu (<i>Adina cordifolia</i> , Hook. f.), by G. E. C. Cox	0 8 0
43. Note on Odina Wodier, Roxb., by the same author	0 8 0
44. Note on Semal or Cotton Wood, by the same author	0 10 0
45. Note on the Miscellaneous Forests of the Kanantha Bhabar, by E. A. Smythies	1 6 0
46. Rate of growth of Bengal Sal (<i>Shorea robusta</i>), I Quality, by S. H. Howard	1 0 0
47. Volume Tables and Form Factors for Sal (<i>Shorea robusta</i>), by the same author	0 6 0
48. Note on Kindal (<i>Terminalia paniculata</i>), by R. S. Pearson	0 6 0
49. Note on Thlagan (<i>Hopea odorata</i> , Roxb.), by A. Rodger	0 7 0
50. Note on Gurjun or Kanyin, compiled by W. A. Robertson	0 4 0
51. An Investigation of certain factors concerning the Resin tapping Industry in <i>Pinus longifolia</i> , by H. G. Champion	0 8 0

IV.—BULLETINS (NEW SERIES)—*contd.*

	PRICE (exclusive of packing, postage, etc.).	Rs. A. P.
*62. Classification of Thinnings (Revised and issued as Forest Record, Vol. XI, Part I)
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